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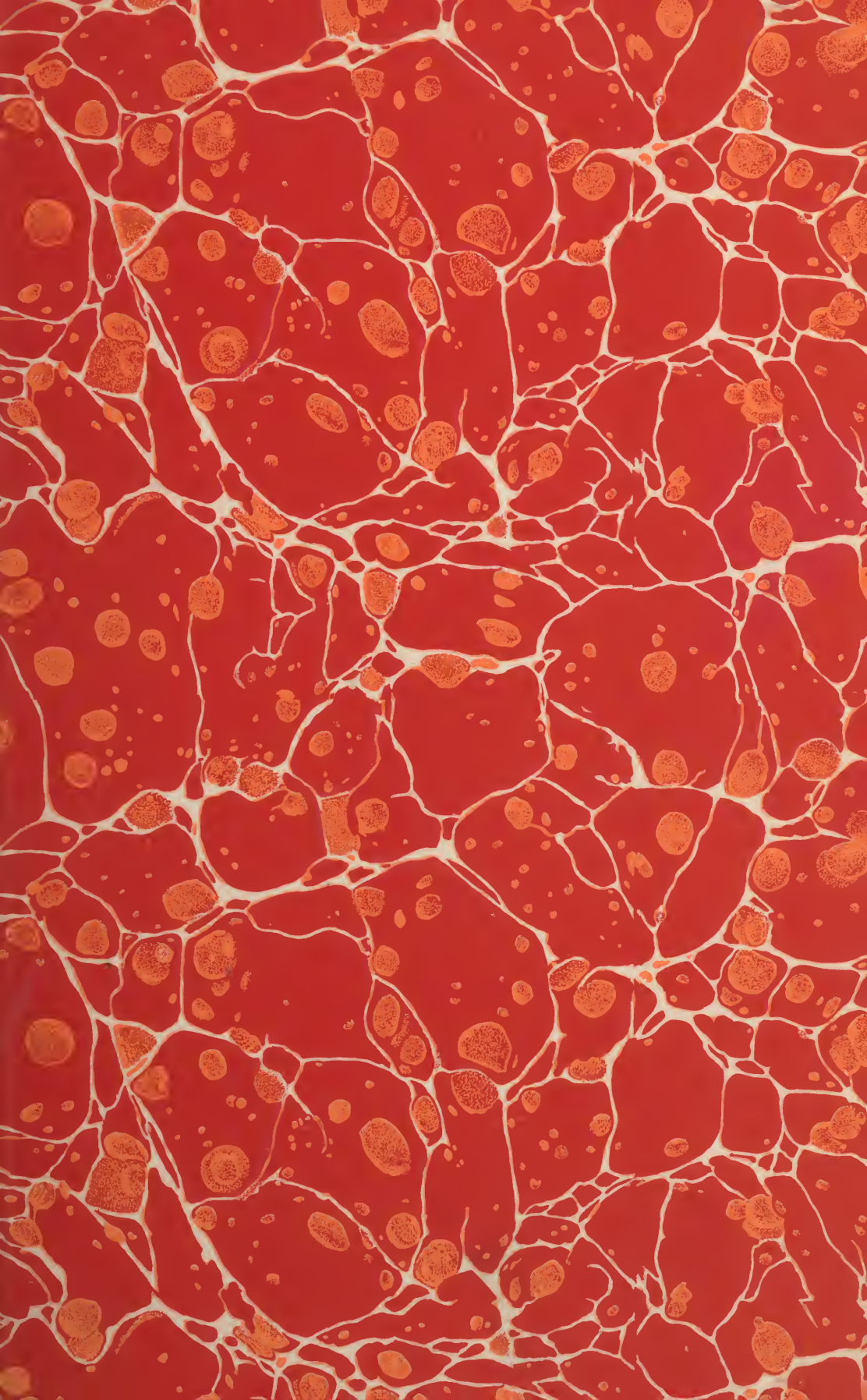


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THE
INTERNATIONAL ENCYCLOPÆDIA
OF
SURGERY.

VOL. III.

THE
INTERNATIONAL ENCYCLOPÆDIA
OF
SURGERY

A SYSTEMATIC TREATISE
ON THE
THEORY AND PRACTICE OF SURGERY
BY
AUTHORS OF VARIOUS NATIONS

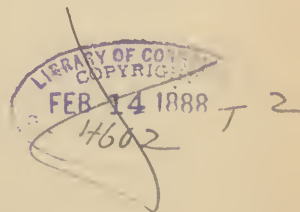
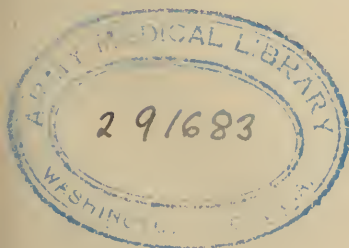
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IN SIX VOLUMES
VOL. III.

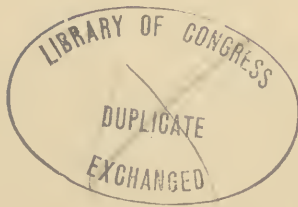
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THE INTERNATIONAL ENCYCLOPÆDIA OF SURGERY.

ARTICLES CONTAINED IN THE THIRD VOLUME.

INJURIES AND DISEASES OF THE MUSCLES, TENDONS, AND FASCIÆ. By P. S. CONNER, M.D., Professor of Surgery and Clinical Surgery in the Medical College of Ohio, Cincinnati; Professor of Surgery in the Dartmouth Medical College, etc. Page 1.

INJURIES AND SURGICAL DISEASES OF THE LYMPHATICS. By EDWARD BELLAMY, F.R.C.S., Fellow of King's College, London; Surgeon to the Charing Cross Hospital; Member of the Board of Examiners, Royal College of Surgeons of England. Page 27.

SURGICAL DISEASES OF THE SKIN AND ITS APPENDAGES. By JAMES C. WHITE, M.D., Professor of Dermatology in Harvard University. Page 45.

DISEASES OF THE CELLULAR TISSUE. By JOSEPH W. HOWE, M.D., Clinical Professor of Surgery in the Bellevue Hospital Medical College, New York. Page 117.

INJURIES AND DISEASES OF THE BURSÆ. By CHARLES B. NANCREDÉ, M.D., Professor of General and Orthopædic Surgery in the Philadelphia Polyclinic; Surgeon to the Episcopal Hospital and to St. Christopher's Hospital for Children, Philadelphia. Page 135.

INJURIES AND DISEASES OF NERVES. By M. NICAISE, M.D., Professor Agrégé in the Faculty of Medicine of Paris; Surgeon to the Hospitals, Paris. Page 179.

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INFLAMMATORY AFFECTIONS OF THE BONES. By L. OLLIER, M.D., Professor of Clinical Surgery in the University of Lyons. Page 745.

SCROFULO-TUBERCULOUS AND OTHER STRUCTURAL DISEASES OF BONES. By EUGENE VINCENT, M.D., Professor Agrégé, Surgeon-in-Chief of the Hospital of La Charité, Lyons. Page 803.

TUMORS OF THE BONES. By A. PONCET, Professor of Operative Surgery in the Faculty of Medicine of Lyons. Page 875.

ALPHABETICAL LIST OF AUTHORS.

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RICHARD BARWELL,
EDWARD BELLAMY,
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GEORGE E. FENWICK,
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CHARLES B. NANCREDE,
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EXCISION OF THE KNEE-JOINT.

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INFLAMMATORY AFFECTIONS OF THE BONES.

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TUMORS OF THE BONES.

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THE INTERNATIONAL ENCYCLOPÆDIA OF SURGERY.

INJURIES AND DISEASES OF THE MUSCLES, TENDONS, AND FASCIÆ.

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INJURIES AND DISEASES OF THE MUSCLES.

IN common with other systems of the body, the muscular is the seat of various injuries and diseases; though in virtue of its anatomical construction, its protection by overlying fasciæ, fat, and skin, and its inherent power of resistance to morbid impressions, such lesions and affections are much less frequently met with than might naturally be expected, taking into consideration the number and size of the muscles and their exposed situation.

MYALGIA.—With a painful state of varying intensity and duration, affecting one or more muscles, every one is familiar. Affecting most frequently the muscles of the neck, of the back, of the chest, and of the calf of the leg, this muscular pain or *myalgia* may be consequent upon strain or limited rupture, upon disease in or about the vertebral articulations, upon nerve-pressure, upon a general or special febrile affection, upon particular poisons, such as those of syphilis or lead, or upon rheumatism or gonorrhœa; muscle-pain being the one constant symptom common to all these conditions. Unquestionably neuralgic in nature in the majority of cases, in some if not all of the rheumatic and gonorrheal attacks it must be inflammatory, since myositic hyperplasias, atrophies, and contractures do at times follow. Recognition of the existence of the pain being perfectly easy, from either the difficulty or impossibility of movement, from the existing muscular spasms, from the facial expression, or from the believed reliability of the patient's statements, it is of chief importance to determine the cause of the myalgia, in order that, this being removed, the effect may cease, as it generally does when it is

possible by therapeutic or operative measures to get rid of the primary trouble. The use of heat, electricity, anodynes or anæsthetics may be required for the prompt relief of the pain.

RUPTURES OF MUSCLE.—Laceration of muscular fibres may be consequent upon either blows from without or the force of the muscle's own contraction; may vary in extent from the slightest tearing, hardly more than simple stretching, to complete pulpification; may be recovered from speedily and perfectly, or may terminate in destruction of the part or even in loss of life. When the result of contraction, this in a healthy state of the tissues is never, or almost never, voluntary; but is a sudden violent movement of a muscle, off its guard, as it were, and unsupported by its associates. When, however, because of existing general disease the muscular fibres have undergone such changes as render them in a high degree brittle (the granular or vitreous degeneration), rupture not infrequently takes place in consequence of voluntary movements even of slight amount. Such an accident is most often met with during the later stages of typhoid fever, but it has also occurred in cases of scarlet fever, yellow fever, and other acute, grave pyrexias; the muscles most frequently damaged are, in the order of relative frequency, the rectus abdominis, the rectus and adductors of the thigh, the gastrocnemius and soleus, the psoas, and the flexors of the forearm. External violence may cause rupture of any of the superficial muscles, and, at times, undoubtedly of some of those which lie more deeply.

Symptoms.—The occurrence of muscular rupture is indicated in typical cases by sudden, sharp pain, accompanied with the sensation of a snapping in the injured region; by characteristic deformity, a well-defined depression—not infrequently, indeed, a wide gap—existing at the place of rupture, with decided swelling above; by extravasation of blood, indicated by swelling and color-changes in the skin, coming on early or late according as the torn muscle is near to or remote from the surface, and varying in amount from the slightest effusion to one of such extent as to constitute a veritable hæmatoma; and by impairment of function, the ability or inability to move the part supplied by the injured muscle depending upon the extent of the laceration. While all these symptoms may be and generally are found more or less clearly manifested in cases occurring in healthy individuals—certainly in all cases of complete rupture of an external muscle—they very often will not be recognized in cases of laceration occurring in the progress of general diseases, unsuspected rupture of large and important muscles being not infrequently discovered upon post-mortem examination.

Secondary Effects of Muscular Rupture.—The effects produced by these injuries will depend upon the muscle affected and the extent of its damage. Slight lacerations will be completely recovered from; and more extensive, or even complete separations, especially of the muscles of the extremities, will usually be followed under proper treatment by little impairment of functional integrity. When one of the abdominal muscles, especially the rectus, is extensively damaged, intestinal obstruction simulating strangulated hernia, or peritonitis, may be developed, and the latter, if not terminating fatally, may cause fixation of a part of the intestinal tube to the abdominal wall.

TREATMENT.—In the management of muscle-rupture, as in the analogous injury of bone (fracture), the essential principles of treatment are the putting the parts in apposition and then keeping them there. The difficulty in accomplishing these desired objects lies in the retractibility of the tissue damaged, this not only causing wide separation at first of the divided ends,

but rendering it difficult, oftentimes impossible, to produce any close approximation, or to maintain it, if secured; still, by rest, position, and appropriate bandaging, with the plaster-of-Paris or the elastic-rubber bandage rather than the ordinary roller, much may be done. Cutting down upon the torn ends and suturing them either with wire or catgut has been advised. Union, which, unless there has been extensive extravasation of blood or suppuration, may be expected, is ordinarily effected by means of an interplacal connective-tissue band, of length dependent upon the degree of retraction. Occasionally, as in rare cases of wound, perfect anatomical as well as functional repair takes place, the new muscular elements being developed either from the cellules on the inner surface of the sarcolemma, the connective-tissue corpuscles of the perimysium, or the migrated white corpuscles; or, as is not at all improbable, from all three sources.

WOUNDS OF MUSCLES.—These may be either subcutaneous or open, and, like ruptures, are attended with retraction and hemorrhage, symptoms which are, as a rule, much more marked in the open than in the subcutaneous variety. While the subcutaneous wounds are ordinarily injuries of but little moment—the extravasated blood being rapidly absorbed, little or no inflammation occurring, and early and very satisfactory repair taking place—the open ones are lesions of very much more importance, the large gap between the divided ends (all the larger because of the free division of the sheath) filling up only through granulations, and the resulting connective-tissue cicatrix very imperfectly substituting the original muscular fibres. As the effects of wounds resemble those of rupture, so the *treatment* is much the same—rest, compression, and approximation as close as possible of the divided ends. In the open wound such approximation can never be very close, and any attempt to increase it by the use of sutures is apt to result in failure, owing to the strong probability of an early tearing-out of the stitches, because of the inflammatory changes produced in the fibres even at some little distance from the wound.

HERNIA OF MUSCLE.—Consequent upon the presence of an abnormal opening in the investing aponeurosis, muscular protrusion may take place; such an opening being the result of a laceration, at the time of a sudden, violent muscular action, or of a wound (as from the passage of a bullet) not followed, as it ordinarily is, by complete union, but by cicatricial rounding off of the edges. These herniæ when suddenly produced are generally associated with acute myositis, and, whether slowly or rapidly developed, with decided impairment of the functional integrity of the affected muscles.

Diagnosis.—Muscular herniæ may be confounded with muscular ruptures—in certain locations, with intestinal herniæ—with blood-tumors, or with abscesses. The diagnosis is ordinarily, however, not difficult. There is noticeable a marked fulness at the time of muscular contraction, disappearing when relaxation takes place, such fulness being more or less firm to the touch according to the degree of muscular development. In the acute cases all movement of the injured parts is painful, in many cases so painful that the use of the muscle is for the time being abolished. When the opening has long existed it can usually be readily detected upon pressure, and if while the finger is kept upon it contraction of the underlying muscle is brought on, the fibres can be felt swelling up into the aperture.

The *treatment* in acute cases consists in rest and methodical pressure, which usually will secure closure of the opening; failing to effect such, the edges of the fascial laceration must be freshened and united by sutures. In old-standing cases this is the only way in which a cure can be effected. In the

majority, though, of these accidents the inconvenience to the individual is so slight that either nothing need be done, or a simple retentive bandage may be applied so as to limit the degree of protrusion.

INFLAMMATION OF MUSCLE.—Primary myositis, not dependent upon injury, contiguous inflammation, diathetic conditions, or parasites, is exceedingly rarely met with. Indeed, it is with many a question whether such idiopathic inflammation can ever take place; and it is agreed that muscular tissue is of all in the body least liable to spontaneously take on inflammation. There are cases met with, however, in which, as is supposed, in consequence of exposure to cold or of excessive use, a muscle-inflammation occurs, presenting the ordinary symptoms of such pathological conditions, and characterized by a peculiar firmness along the course of the muscle, the “woody-hardness” of Velpeau. Such inflammation may terminate either in resolution, which is most usual, or in sclerosis, or, which comparatively seldom occurs, in suppuration.

Traumatic myositis is frequently met with, much more so in men than in women, on account doubtless of their greater exposure to the action of the developing causes. It gives rise in greater or less degree to pain both on pressure and movement; to limited swelling, the outline of which corresponds to the muscular contour (such swelling being chiefly due to effusion and exudation, but in part at times to extravasation of blood); and to interference with or entire arrestation of the functional action of the affected part; with associated heat, redness, and it may be ecchymoses in the overlying skin. As a rule, such muscle-inflammation is of little importance, being but one of many pathological conditions resulting from the causative injury, and usually disappearing without any treatment other than that proper for the relief of the general effects of the accident. In this, as in the very much rarer idiopathic form of myositis, suppuration seldom takes place (except when the psoas is the muscle affected, in which case it is almost certain to occur); and when it does, such occurrence will generally be found to be due to a predisposing, cachectic condition of the patient, with perhaps an unusually large extravasation of blood.

In most cases such suppuration is readily recovered from, either with complete muscular restoration, or with the formation of the ordinary connective-tissue cicatrix. At times, however, more often in badly-nourished subjects, but sometimes in the robust, a diffuse inflammation of very grave character is met with, affecting few or many muscles, and very analogous to acute osteo-myelitis and acute phlegmonous periostitis. This “muscular typhus,” which is generally, if not always, of septic origin, and in which the diseased muscles rapidly break down and septicæmic conditions are early manifested, is, if left to itself, almost necessarily mortal, and the fatal result can be averted at the best only by early and free incisions, and the consequent prompt evacuation of pus and separation of the necrosed tissue.

Differing from this in its localization and in the less dangerous constitutional symptoms which result, is the acute necrosis of a single muscle or an associated group of muscles; as in the case reported by Lücke, in which, following a fall which produced no pain nor apparent extravasation, the whole mass of muscles on the antero-external surface of the leg perished, in consequence, as the reporter believed, of embolism of the supplying artery, though such an explanation may well be questioned, since the pulsation of the dorsalis pedis artery remained unaffected throughout.

Occasionally the myositis is a chronic one, swelling with associated “woody” hardness being ordinarily the only symptom present. When not consequent upon inflammation of contiguous joints or bones, most of these slowly-

developed inflammations are of syphilitic origin. Not so very rarely there are met with, most usually in so-called scrofulous subjects, *cold abscesses*, single or multiple, varying in size, but never very large, easily to be felt in the substance of the muscle, and because of their firmness and the absence of all inflammatory symptoms often mistaken for muscle-tumors. When by the coalescence of several of the originally separated abscesses a single and rather large one is formed, a well-defined limiting pyogenic membrane will be found to exist.

CONTRACTURES.—As a result of the connective-tissue sclerosis, muscular shortenings occur, with produced deformities of varying degree and permanency. The hardened and contracted belly of the muscle can easily be felt, and neither actively nor passively can full extension be secured. When treatment is early instituted, restoration of the muscle to its functional integrity often takes place, but when the diseased condition has long existed, the muscle is, ordinarily, irreparably damaged, and either myotomy or tenotomy will be required before the resulting deformity can be corrected. In the “late rigidity” associated with paralysis of cerebral origin, the flexors of the upper extremity being the muscles especially affected, the contracture may be expected to be permanent. Rest, frictions, methodical massage, stimulating applications, and electricity, are each and all of service in promoting the cure. As will hereafter be seen, many of these conditions are of syphilitic origin, and to be relieved only, if at all, by the use of mercury and the iodides.

All muscular contractions are not dependent upon inflammatory sclerosis. They may be rather apparent than real, as when the opposing muscles are paralyzed. Oftentimes they are reflex in origin and protective in character, as is constantly seen in the case of the rigid muscles about an inflamed joint; though in such cases the contractions frequently become real in course of time from degenerative changes following the abnormal approximation of the two ends of the muscle. Such rigidity, as of the adductors in morbus coxarius, and of the erector spinæ in vertebral caries, is not infrequently the earliest symptom noticeable, and its detection should always lead to a very careful examination of the neighboring joint or joints. Though for a considerable length of time these reflex contractions are dependent upon nerve irritation, and the muscle remains perfectly healthy, yet, if long-continued, inflammatory and degenerative changes occur, and contracture takes the place of contraction—the active yielding to the passive state. In hysteria, contractions, lasting sometimes for years and then disappearing, it may be suddenly, are met with; and the cutting off of the blood-supply may give rise to contractions much akin to post-mortem rigidity.

HYPERTROPHY OF MUSCLE.—Increase in the size of a muscle may be real and due to the formation of new muscular elements or enlargement of those already existing, or may be apparent and consequent upon the presence of fat, connective-tissue hyperplasia, or excessive development of the lymphatics and bloodvessels. It may be congenital or acquired, limited or general, symmetrical or unilateral. Not infrequently, as in various classes of workmen, it can be directly traced to disproportionate use of the affected muscle or muscles, and in certain pathological conditions, as in cardiac hypertrophy, and in the thickened bladder walls associated with prostatic enlargement, it is compensatory and salutary. At times the muscular overgrowth is associated with equal or greater increased development of bone, fasciæ, and skin; in other words, the whole affected region is hypertrophied. Reduction in size of the hypertrophied muscle may often follow diminished functional activity, or

rest, as absolute as may be, aided by compression. In hypertrophy of the tongue, partial ablation is at times required. Macroglossa, however, is very rarely due to actual increase in number and size of the muscular fibres, but generally to great over-growth of the lymphatics and bloodvessels of the part, with more or less hyperplasia of the connective tissue.

A few cases have been observed of "progressive muscular hypertrophy of adults" (Benedikt), mostly affecting "the upper extremity, and, as a rule, only one," and confined to one side when in the lower extremity. The greatly enlarged muscular fibres have, in certain cases, been found capable of doing much work for a short time, though soon tiring; while in other cases the actual strength of the muscle has been lessened rather than increased.

ATROPHY OF MUSCLE.—Atrophy of muscle may be either simple or degenerative, there being in all cases a diminution in the size of the muscular fibres, and corresponding lessening of the muscles themselves, except in the comparatively rare instances in which atrophy is masked by excessive fat development. This change may be consequent upon either disuse, nerve-lesion, injury of a bone or joint in close proximity to the muscle, disease of spinal or cerebral location—atrophy, however, rarely occurring in the latter, unless the pons be the seat of the affection—or some constitutional malady, attended with a depraved or poisoned state of the blood.

In simple atrophy there is found only a diminished size of the primitive fibre, no change occurring in the connective tissue except in very pronounced cases. Such is the form of atrophy usually declared to be met with as the result of muscular repose or disuse. It is questionable, however, whether simple disuse produces any real muscular atrophy. Certain it is, that when the cessation of voluntary movement does not depend upon some injury of joint, bone, or nerve, even though it be very prolonged, there is often no resulting diminution in the size of the muscular elements; and in the great majority of cases of disuse, the atrophy is without doubt reflex in its character. Simple atrophy is found also in a considerable proportion of cases of nerve injury; in a majority of those of fracture and dislocation of the vertebral column, in which death does not early occur; in vertebral caries; and in lesions confined to the brain. It is the form most usually met with in cases of infantile paralysis and of progressive muscular atrophy.

Much more interesting from a pathological point of view, and of much more importance, clinically considered, are the atrophies accompanied by degenerative changes. These may be either *granular*, *pigmentary*, *fatty*, or *waxy*.

Granular Degeneration.—In this form of degeneration, which is not infrequently associated with the fatty, the muscle-fibre is found to have lost its clearly defined striation, and the sheath to be occupied with a number, greater or less according to circumstances, of granules of varying size and of albuminoid character. By some regarded as simply a passive change, due to causes outside of the muscle, it has by others been considered as the result of inflammation; in fact, simply the cloudy swelling of the early stages of that process.

Pigmentary Degeneration.—Pigmentary degeneration, as its name would indicate, is characterized by the presence of dark pigment granules within the sarcolemma, such deposit in the muscles of the human subject, other than the cardiac, being always pathological, and often found in connection with the atrophies consequent upon cachectic conditions, upon much diminished food supply, and upon the marasmus of old age. It is as yet undetermined

whether the pigment is of hæmatic origin, or whether it results from changes in the coloring matter of the muscle.

Fatty Degeneration.—In the fatty degeneration proper, fat granules are found in varying amount in the sarcous elements, in the earlier stages only in the immediate vicinity of the nucleus, but at a later period substituting more or less completely the contractile substance, with corresponding destruction of the invaded part of the muscle. This change, usually slowly produced and of limited extent, may, on the other hand, be very rapidly developed, and may affect, more or less, all the muscles of the body, as notably in cases of phosphorus poisoning. Such fatty-degenerated muscle-fibre must generally, perhaps always, be absorbed, though possibly at times the absorption may be only of the fat granules. It is very probable, judging from the results of experimental investigations upon similar changes occurring in certain of the lower orders of animals, that the absorption of the substituted fat in chronic cases may occasionally be followed by muscular re-development. Besides this true degeneration, fat is found both within and without the sarcolemma as an infiltration or accumulation, either producing no effect upon the contractile substance, or destroying it simply by pressure. The deposit in the connective tissue between the fibrillæ, pathological in many cases, as, for example, after nerve lesions (when, according to Vulpian, true fatty degeneration never occurs), is very often met with as a physiological change, purely compensatory, filling up the spaces that are left by the fibres undergoing simple atrophy.

Waxy Degeneration; Vitreous Degeneration.—In this form, attention to which was first called by Zenker, the muscular elements are found to be converted into a peculiar, transparent, waxy or vitreous mass, exceedingly friable, readily breaking up into cuboidal blocks, while the muscular connective tissue at the same time undergoes proliferation. This is the form of degeneration so frequently met with in yellow fever and typhoid fever, and which occurs also in typhus, scarlet fever, and some other acute febrile affections. It has been observed also in cases of tetanus, and in the immediate vicinity of tumors, and has occasionally, though very rarely, been found after nerve lesions. Not all the muscular fibres usually are involved, some perfectly healthy being found in immediate relation with those more or less completely degenerated. As might naturally be expected, this condition is associated with weakness, more or less pain, and marked impairment of the functional integrity of the muscles, which, as we have already seen, are not infrequently ruptured in consequence of very slight violence.

Various theories have been proposed in explanation of these degenerative changes—that they are due to a peculiar infection; to high heat, which condition Claude Bernard has proved is a poison to the muscular tissue; and to muscle inflammation and its results: the latter is the view most generally adopted at present. Erb maintains that it is of the nature of a cadaveric change, requiring for its development an imbibition of serum and the absence of post-mortem rigidity, which latter condition is not developed in muscles thus affected. However produced, one thing is very certain, that it is a change that can end only in the destruction of the affected fibres. The vitreously degenerated sarcous elements must disappear, and new fibres take their place, in cases that recover. Whether these new fibres are developed wholly from the muscular cellules, or partly from cells of or outside of the perimysium, is a question as yet unsettled; or, as Strauss has expressed it, “The influence of the non-participation of the cellular elements of the perimysium, in muscular regeneration, is far from being as yet absolutely demonstrated.” The same

question, as we have already seen, comes up in the consideration of the regeneration of muscular fibre after wounds and ruptures.

Under what circumstances are these several forms of degenerative atrophy likely to occur? When the muscular affection is consequent upon lesions of the anterior horns of the spinal cord (the "amyotrophies of spinal origin" of Charcot), there may be no degeneration whatsoever, simple atrophy alone existing; but in the great majority of cases the granulo-fatty change will sooner or later be detected, sometimes with associated pigmentary deposits, and the hyperplasia of chronic myositis will be found present in the connective-tissue framework of the muscle. If there be any acute inflammation of the cord, fatty degeneration rapidly follows. In a case reported by Little, of dislocation of the fifth from the sixth cervical vertebra, complete atrophy of the muscles of the forearm was present by the end of the second week. When it is nerve injury that has given rise to muscle-lesions, these latter are, as we have seen, according to Vulpian's investigations, always limited to the perimysium, and are hyperplastic and fatty. Others, however, claim that fatty degeneration of the muscular elements at times takes place. When the nerve damage is an irreparable one, the resulting atrophic changes are permanent and likely to go on from bad to worse; but when repair can and does take place, restoration of the muscles to their normal condition usually occurs, and that sometimes very rapidly. Markedly diminished blood-supply will cause the fatty change, as is physiologically observed in advanced life, and pathologically in cases of decided though incomplete arterial stenosis. Vitiating of the quality of the blood produces the same effect; sometimes very rapidly and generally, as in the acute grave pyrexias and after taking certain of the poisons, such as phosphorus and arsenic; sometimes more slowly and in more limited areas, as in the lead palsies.

The atrophy always to a greater or less extent associated with joint inflammations and fractures, which is simple and not degenerative, cannot, as long believed, be due to disuse, except, perhaps, in certain very chronic cases of arthritis, but is to be regarded as reflex. "It seems dependent upon disordered nervous influence, and often appears proportionate to the coincident pain, as if it were due to the disturbance of some nutritive nervous centre, irritated by the painful state of sensitive nerve fibres" (Paget). In case of fracture, Gosselin believes the wasting to result from "a change in the distribution of the nutritive material consequent upon the work of consolidation." The atrophy of stumps, which is also of the simple form and due to nerve-injury, has been found by Vulpian and others to be associated with wasting of that portion of the anterior columns from which arise the nerves distributed to the parts removed.

Three affections, in each of which muscular-atrophy is a most marked symptom, deserve special consideration, viz., progressive muscular atrophy, infantile paralysis, and pseudo-muscular hypertrophy.

Progressive Muscular Atrophy.—Progressive muscular atrophy, recognized by Bell but much more carefully studied by Cruveilhier, and subsequently by Duchenne, is characterized, as its name would indicate, by a progressive involvement of the various muscles of the body. Beginning usually in those of the hand (the external interosseous being ordinarily the muscle first affected), though sometimes commencing in those of the shoulder, and even, in rare cases, in those of the lower extremity, it gradually proceeds from muscle to muscle until the most marked atrophy characterizes the appearance of the upper part of the body; and the ultimate involvement of the respira-

tory muscles, or exhaustion, or associated gangrene from pressure, brings on a fatal termination, which is the almost certain result of the disease. Occasionally it has been found to be, not, as usually, chronic, but acute—rapid atrophy and early death occurring. Originally believed by the majority of pathologists to be primarily a myositis (and Friedreich has of late maintained the same theory of its nature), it is to-day generally recognized as originally a nerve lesion, the anterior portion of the spinal cord being the seat of the trouble. The muscular disturbance is one of inflammation, chronic in the great majority of cases, very rarely, as we have seen, acute; the myositis causing interstitial and fatty degeneration of the muscular elements, sometimes associated with proliferation of the connective tissue.

As this is a disease of middle life, so also is it one of the male sex, which is much more frequently affected than the female; and a strong hereditary influence has been observed in many cases. While perhaps not consequent upon them, its development is certainly favored by the existence of diseases attended with exhaustion, and dyscrasie, such as syphilis, lead-poisoning, etc. How much influence in its production is exerted by over-use, still remains a question. Cases have been observed in which the starting-point seemed to have been muscular injuries, crushings, etc. In the rare cases in which the lower extremities have been first involved, the disease has been observed usually in young subjects, and a pseudo-hypertrophic condition has been found associated with it.

The *diagnosis* of progressive muscular atrophy, at least when the disease is well developed, is easy. The peculiar wasting and the gradual progress, associated as it often is with fibrillary contractions, either occurring spontaneously or developed by slight blows, and the later, contracted condition of the muscles, with resulting deformities, such as the characteristic “griffed” hand, present an aggregation of symptoms which cannot be mistaken. At times, owing to an increase of the development of fat, atrophic deformity may be for a time masked. The *prognosis* is exceedingly grave, a fatal termination occurring in the great majority of instances.

Infantile Paralysis.—In this affection, belonging as its name indicates to the earlier years of life, there are observed much the same changes as in progressive muscular atrophy. It is a disease, however, not only of childhood, but one which is ordinarily acute, the paralytic condition of the muscles developing at first, frequently in the course of a few hours, or, at most, days, and the atrophy, which is usually simple, or, at times, associated with fibrous or fatty degeneration, quickly manifesting itself, having been observed as early as the fifteenth day, though commonly not for a month or two. The seat of the lesion has been very satisfactorily determined, and has been shown to be in the anterior horns of the spinal cord, there being a primary poliomyelitis with destruction of the cells. Here, as in progressive muscular atrophy, deformity, especially located in the lower extremities, is produced, and this deformity usually brings the case sooner or later under the care of the surgeon. The special management of these cases belongs properly to the department of orthopædic surgery, and will be considered in another part of the work. In very many cases, however, by early recognition of the disease and the institution of proper treatment (and of this the use of electricity is the most important element), the muscular wasting may be arrested, and partial, if not complete, restoration of the functional integrity secured.

Pseudo-Hypertrophic Paralysis.—This curious affection, which is also a disease of early life, in many respects strongly resembles progressive muscular atrophy and infantile paralysis. It differs from the former mainly in

the age at which it is manifested, and in the primary involvement of the lower, rather than of the upper extremity (although sometimes the latter is first attacked, and then usually there is simply progressive muscular atrophy without hypertrophy); and from both in the apparent, sometimes massive, increase of the size of the muscles. This increase, however, is only apparent, the muscular elements themselves being either unchanged or, as is sometimes the case, atrophied—such atrophy being associated with an excessive development of fat and proliferation of connective tissue. Not infrequently it happens that only a few of the muscles are hypertrophied, these being generally those of the calf and of the gluteal region, the other affected muscles, especially in the upper half of the body, being greatly wasted. Whether or not this affection, like progressive muscular atrophy and infantile paralysis, is of spinal origin, is still a question; the majority of observers have denied the existence of any associated or causative spinal lesion.

OSSIFICATION OF MUSCLE.—As the result of chronic inflammation, true bone formation may take place in muscle, such development being either limited or general. In the former case, which is vastly the more common, the precedent connective-tissue inflammation is due, in the great majority of instances, to frequently repeated and long continued but comparatively slight traumatic irritations (as in the so-called “exercise bones,” which, however, are generally located in the tendons rather than the muscles), but at times is of syphilitic origin. Not very infrequently circumscribed ossification will be found to have affected muscles in close proximity to exuberant callus after fracture. Once formed, the osseous masses or plates can usually be felt without difficulty, though their existence may be discovered only after death; and, according to their size, they will give rise to much, little, or no appreciable impairment of the full natural action of the muscle. Ordinarily they need not be interfered with, but at times they require removal.

Myositis Ossificans.—Of muscular inflammation, general in its character, and terminating in the conversion of the parts affected into bone, a few cases have been observed. Commencing in early life, even in infancy, affecting primarily the muscles of the neck and back, and then spreading to those of the extremities, and subsequently to those of the trunk, but sparing those of the tongue, larynx, and œsophagus, the heart and the diaphragm, and those of the genitals, and affecting the abdominal muscles only to a limited extent, this may be regarded as primarily a hyperplastic inflammation of the connective tissue, producing consequent atrophy of the muscular elements, and terminating in osseous transformation. As thus far observed, it does not seem to be hereditary. Its progress is slow and irregular, influenced to some extent by accidental and outside circumstances, but sooner or later the case terminates in death; either because of exhaustion, of involvement of the external muscles of respiration, or of local gangrene.

By most writers this affection has been declared to be independent of any nerve lesion, but Hayem has questioned if it has not close relation with an affection of the nervous system, since its characteristic lesions are inflammation, sclerosis, and atrophy, much resembling those of spinal origin. As far as has yet been determined, it is incurable by any method of treatment, though the affected individual may live for a number of years.

RHEUMATIC AND GONORRHOEAL INFLAMMATION OF MUSCLE.—So-called “muscular rheumatism,” which in many cases doubtless is rheumatic only in name, is, as has already been stated, sometimes, perhaps generally, a true myositis, usually of short duration and terminating spontaneously in resolution, but at

times chronic in character, and giving rise to organic changes in both the sarco-s elements and their investing connective tissue. In no case has suppuration been known to take place. It is most frequently located in the muscles of the neck (*rheumatic torticollis*), in those of the chest (*pleurodynia*), and especially in those of the back (*lumbago*). Once occurring, it is very liable to recur. Attributed oftentimes to the influence of drafts of air striking upon a surface over-heated or in a state of active perspiration, in many cases, perhaps in the majority, it is really due to twists, strains, or ruptures of the muscular or tendinous fibres or of their sheaths; in other words, is actually traumatic. Diagnosed by the pain and inability to move, and the muscular contraction with sometimes resulting deformity, it is to be treated by rest, heat, stimulating applications, opium by the mouth or, still better, hypodermically, and especially by electricity, the effect of the application of which is often very rapidly beneficial.

As a complication of gonorrhea, so-called "gonorrheal rheumatism" sometimes occurs in the male, more rarely in the female. In this affection the muscles have in a few cases been evidently the seat of an inflammation differing from ordinary myositis only in its exciting cause, and in its constant association with arthritis, usually mono-articular.

SYPHILITIC AFFECTIONS OF MUSCLES.—Affections of the muscular system consequent upon syphilitic infection, may manifest themselves at an early or late stage of the disease. In the former they are such as arise from nervous disturbance (pain, weakness, unsteadiness of action); in the latter, from organic changes and deposits.

Syphilitic Myalgia.—In the secondary period of syphilis, myalgias are often met with, and, indeed, in mild form, at some time or other, are almost constant. They are much more common in women than in men (as are all the specific disturbances of nerve-origin), are worse at night or in the early morning than in the daytime, are aggravated by exercise or pressure, last a variable length of time, and always disappear, sometimes as suddenly as they came on. The pain is located in the belly of the muscle, and ordinarily in only a part of that; it may affect one or more muscles (those of the thighs and legs being the more usual seats), is often indefinite and wandering, and may be associated with, and—unless care be taken in the observance of its phenomena—may be easily mistaken for, pain arising from affections of the neighboring joints, bones, or tendons. The *treatment* must be both anti-syphilitic and anodyne, and much benefit will often follow local counter-irritation, and still more frequently the employment of hot applications, especially of the vapor bath. Muscular weakness is always present to a greater or less extent, and may be so prominent as to prevent the taking of any exercise, or even the getting out of bed. As the result of inaction, or as a reflex phenomenon, atrophy occurs, sometimes in high degree.

Syphilitic Tremor, etc.—As was originally pointed out by Fournier, there may occasionally at this period of syphilis be detected in certain of the muscles tremblings, fibrillary contractions, not due to any central nerve-lesion, but "simply a functional disturbance, essentially temporary, and necessarily benign." Arising suddenly, affecting primarily and chiefly the muscles of the upper extremity, and ordinarily only a part of these, this trembling may be both seen and felt, and can without difficulty be graphically traced. The duration of the affection varies from a few days to five or six months, and in the more protracted cases (lasting from "four to eight or ten weeks"), which are those usually met with, the tremblings are frequently intermittent.

Syphilitic Contracture.—As a consequence of a myositis of low grade, occurring both in the earlier and later periods of syphilis—even as early as the second month, according to Mauriac—muscular contracture at times takes place. Actual shortening may or may not exist, but whether it does or not, full extension cannot be made, the degree of limitation having been observed at times to exceed 90° . The biceps flexor cubiti is the muscle that is almost always affected, and there has been observed at the same time contraction of the triceps extensor, so that true muscular ankylosis has been caused. In the contracture occurring in the early period of syphilis, though there may be some little pain produced by pressure over the musculo-tendinous junction, the progressive flexion is the symptom that will at once attract attention and permit of a diagnosis being made. The muscle and all the structures entering into the formation of the elbow-joint are apparently perfectly healthy; “the patient presents himself with the forearm flexed upon the arm and immobilized in that position,” and that is all. By the ordinary anti-syphilitic treatment this early rigidity may usually be made to disappear.

The contractures coming on later, and not due to gummata, are the result of diffuse myositis, there being produced the “simple fibrous inflammation” of Virchow in the midst of the interstitial tissue of the muscular bundles, a connective tissue forming “which hardens and destroys, after having caused their atrophy, the primitive muscular fibrillæ.” The biceps is the usual seat of this form of contracture also, but by no means as exclusively as of that already noticed. In many of these late-appearing cases it is very probable that the causative lesion has been not a primary myositis, but a bursitis or an arthritis which has either disappeared or is lost sight of in the presence of the secondary muscle-inflammation.

Gummata of Muscle.—Gummy tumors are not infrequently met with in the muscles, especially in those of the upper extremity and the neck. Their histological character is the same as that of those located elsewhere, they being made up of young round cells with single nuclei that rapidly tend to undergo fatty degeneration. The perimysium is probably the original seat of the gummatus deposit, either no change or a fatty degeneration of the muscular elements being seen, according to the period of observation. Sometimes escaping notice, these gummata, which frequently attain quite considerable size, usually attract attention both on account of their volume and the functional disturbances to which they give rise, though their nature may be misunderstood, a gumma being sometimes mistaken for a sarcoma or fibroma, or, in the tongue particularly, for a carcinoma.

The *diagnosis* may, generally, be readily made by remembering that gummata are swellings of the muscles rather than tumors in them; by noting their firmness, the induration being most easily detected when the muscle is in a state of relaxation, though the natural hardness is greatest during contraction; and by observing their location in the long muscles near their points of insertion, their occurrence in syphilitic subjects, and the results of anti-syphilitic treatment. They usually belong to the accidents of the later periods of syphilis, but at times are met with during the secondary stage. Under proper treatment, their disappearance may generally be secured in the course of a few weeks, or at most months, and even when left to themselves they sometimes disappear. Usually, however, they after a time soften, break down, and by the establishment of sinuses discharge themselves, or, as is more common, again become harder and undergo calcareous or even osseous transformation. It is doubtful if they ever suppurate; indeed, Mauriac has declared that the non-formation of pus is one of their characteristics which is of great value in the establishment of a differential diagnosis.

Contracture of greater or less degree may be produced by the presence of gummata, and such contractures at times remain during the entire after-life of the individual affected, though the gummata themselves may have disappeared long before death. The functional integrity of the muscle is always more or less impaired when cartilaginous or, still more, osseous degeneration has taken place.

The *treatment* of gummy tumors is constitutional, consisting in the administration of the iodides, either with or without mercury. Local applications are of little or no benefit, and extirpation of the tumors, which has at times been practised (commonly, it is true, because of an error in diagnosis), is quite unjustifiable.

TUMORS OF MUSCLES.—Tumors may be located in muscles either by original development, or by extension from neighboring parts. They may be either benign or malignant in character, both sarcomatous and carcinomatous growths being embraced in the latter division.

Non-Malignant Tumors.—Primary *lipomata* and *enchondromata*, though found in muscles, are pathological rarities, much more so than might be supposed, taking into consideration the amount of connective tissue and supported fat that is found in the muscular structure.

Vascular tumors are much more common, both those due to dilatation and those arising from rupture of vessels. The former (*angiomas* proper) are seldom primary, and almost never purely muscular, the skin and subcutaneous tissues, as well as the muscles, containing the growths at the same time, either by association or by extension. As shown by Broca, "these erectile tumors of muscle are always principally venous." *Hæmatomata* following muscle-ruptures are quite common, and when superficial may usually be readily detected by the fulness and softness of the existing swelling, and by the generally-associated discoloration of the skin. In the deeper muscles (and it is in these, especially in the rectus abdominis, that the extravasation-tumor more often occurs) the swelling may be overlooked or mistaken for that dependent upon the contraction of the torn fibres of the muscle. As we have already seen when treating of muscular ruptures, the very nature of the accident may be altogether misunderstood, and the case treated as one, for instance, of intestinal obstruction. In cases of doubt, exploration with a fine trocar or the needle of an aspirator will usually establish the diagnosis. Suppuration, though not very likely to occur, does at times take place, and may be the cause of death, as when an abscess in the rectus abdominis bursts into the peritoneal cavity.

Though usually not very large, the hæmatoma occasionally reaches an extraordinary size, as in Virchow's case where the tumor was over $3\frac{1}{4}$ inches long, $2\frac{3}{4}$ inches wide, and $2\frac{1}{4}$ inches thick, the torn muscle being the right iliacus internus and the patient a "bleeder;" and as in Richardson's case, in which rupture of the right rectus abdominis from muscular effort was followed by a hemorrhage from the torn internal epigastric artery to the amount of a half-pound clot, occupying a cavity made by the retraction of the torn muscular fibres to the extent of from "one and a half to two inches." Cure ordinarily takes place by absorption, but at times a firm, thick, cartilaginous sac-wall with contained shrivelled and broken-down corpuscles remains ever afterwards, causing more or less disturbance of the muscular movements.

The *treatment* appropriate for the rupture is that best fitted to produce removal of the extravasated blood, aided, if necessary, by aspiration. If the coagulum is too firm to be thus gotten rid of, after a reasonable length of time has been allowed for the occurrence of absorption, without this having taken place, it will be advisable to cut into the tumor and turn out the

contents, or, if necessary, cut away its investing sac. With antiseptic precautions the chances are that such radical treatment will be attended with but little danger.

Malignant Tumors.—The malignant tumors, *sarcomata* and *carcinomata*, are often found involving the muscles, the former both primarily and by extension, the latter probably always secondarily, though it is still held by some that true primary cancer of muscle may occur. That the connective-tissue type of malignant growths should spring up and develop in muscle is only what naturally might be expected. Occasional specimens of mixed fatty, vascular and sarcomatous tumors have been observed. But one form of treatment is to be thought of in these cases of malignant growth; thorough removal of the affected parts. Some have even gone so far, recognizing the ready secondary involvement of muscles in close proximity to cancers, as to insist not only upon the propriety but the necessity of the removal of such muscles, even though they may seem to the naked eye to be perfectly healthy. Particularly would they have this rule observed with reference to the pectoral muscle in carcinoma of the breast.

Parasitic Tumors.—Parasitic tumors are consequent upon the entrance into and development in the muscle of either the *echinococcus*, the *cysticercus*, or the *trichina*. The first of these (*echinococcus*) has been comparatively seldom observed, is ordinarily of slow growth, and causes usually but little disturbance and that simply by its size. At times a chronic myositis, occurring about the parasite, causes its inclusion in a thick-walled sac, and occasionally its presence lights up an acute inflammation which may result in the formation of abscess and in spontaneous discharge. The diagnosis of hydatid in muscle must generally be based upon the recognition of a slowly enlarging cyst with absence of all inflammation, and finally (and this will often be the only evidence of value), the discovery in the removed fluid of the "hooklets."

The *cysticerci* are much more frequently met with in the muscles, but their presence is quite unlikely to be recognized, since, unless possibly when in large numbers, they produce few or no symptoms, not even a characteristic muscular weakness, and the little swellings they may cause can rarely if ever be detected before death.

Of much greater importance are the effects of the entrance into and lodgment in the muscle of the *trichinæ*. Transported from the alimentary canal either along the blood-currents or by self-progression through the connective tissue, the embryo-parasites soon find their proper place of development in the muscular fibrillæ, where they excite an acute myositis, as evidenced by pain, cramps, indurations, tenderness on pressure, and marked impairment of function, and, microscopically, by destruction of the sarcous elements and thickening of the sarcolemma. Even before the entrance of the worms into the muscles, there is experienced a "muscular lameness," the cause of which is still uncertain. The severity of these earlier muscular symptoms is directly proportionate to the number of the *trichinæ*, as indeed are all the symptoms of the disease. After having attained their full maturity the parasites become encapsulated, and a state of chronic myositis succeeds to the acute, its duration and severity being exceedingly variable. Generally, calcareous deposits sooner or later take place in the capsule-walls, and then the little tumors become readily visible to the naked eye. The after-life of these encysted *trichinæ* may be short or long—sometimes even longer than that of the individual in whose tissues they are lodged.

INJURIES AND DISEASES OF TENDONS.

RUPTURES OF TENDONS.—Much more frequently than similar injuries of muscles, ruptures of tendons may take place as the result of sudden violent efforts, the occurrence of such an accident being indicated by a snap, often both felt and heard, by pain, by immediate arrestation of muscular movement, and when the tendon is, as is generally the case, in the lower extremity, by falling of the body. Oftentimes there is a visible depression at the place of injury, and upon palpation a distinct sulcus of varying width can readily be detected, the examination when made early causing little or no pain. The entire tendon generally gives way, but partial rupture may take place.

In the majority of cases it is either the tendon of the rectus femoris below or above the patella, the tendo Achillis, or the tendon of the triceps extensor or that of the biceps flexor cubiti, that is broken, the relative frequency being in the order stated. As in the similar injury of a muscle, approximation of the separated ends of the tendon is to be favored as much as possible by position and appropriate bandaging, and rest must be maintained, best by immobilization of the limb. From six weeks to two months is usually required for the completion of the repair. The loss of muscular power generally resulting from the presence of a long connective-tissue band between the tendon ends (and it is in this way oftentimes that repair takes place), makes it probable that when there is wide gaping the wisest course is to suture the tendon at once, a procedure that, antiseptically carried out, seems to be attended with very little risk.

When there is rupture of the tendon of the *rectus femoris*, or of the *ligamentum patellæ* (and these should be considered with reference to this accident as one and the same tendon of insertion, with a contained sesamoid bone), it is almost always due to an unusual and involuntary muscular contraction, the fall being secondary, the consequence and not the cause of the injury. As in fracture of the patella, from which lesion alone a differential diagnosis is to be made, there is immediate inability to lift the extended leg, and more or less inflammation of the knee-joint is likely to be quickly developed.

In rupture of the *tendo Achillis*, it is generally impossible to either stand or walk, and the tendinous interspace can be shortened by forced extension, and lengthened by forced flexion of the foot upon the leg. When the long head of the *biceps flexor cubiti* has given way, the part of the muscle steadied by the short head will be seen upon voluntary contraction to be thrown prominently into relief, while the rest remains flaccid.

WOUNDS OF TENDONS.—These may be either punctured, subcutaneous, or open. The former are usually of little importance, either no symptoms being manifested, or slight ones only, spontaneously passing off in the course of a few hours or at most days. At times, however, as the result ordinarily not so much of the prick as of the entrance thereby of septic material, severe inflammation is developed, with consequent suppuration within the sheath and necrosis of the tendon, or with grave constitutional disturbance that may be the cause of a fatal result.

Complete *subcutaneous* wounds, typical examples of which are met with in operations of tenotomy, are attended with a distinct snap and decided separation of the ends of the tendon, with consequent depression at the seat of injury, always to be felt and usually to be seen. The attendant hemorrhage is slight, and the pain not severe. Plastic effusion takes place around and between the separated ends of tendon, a connective-tissue callus is developed, contrac-

tion of this interposed band occurs, and in the course of a few weeks the reparative process is ended. The restoration of the tendon to its original functional integrity is more or less perfect according to the closeness of the primary approximation, the absence or presence of suppuration (which at times occurs), the degree of quietude maintained, and the healthy or unhealthy condition of the system at large. The *treatment* of these wounds is usually very simple, consisting in the enforcement of rest, with compression and immobilization of the limb. Whether or not the divided ends of the tendon should be brought as nearly as possible together, or should be kept separated, will depend upon whether the wound is one accidentally made in a healthy tendon, or intentionally in one which is contracted, in order that deformity may be corrected.

Open wounds are injuries of much more gravity, severe local and constitutional symptoms very often being developed. The retraction is greater and the hemorrhage more profuse. Inflammation is always excited, except in the rare case in which primary union of the divided overlying soft parts quickly converts the open into a subcutaneous wound. When it is a tendon of the hand or foot which has been divided, the inflammation is very likely to spread rapidly along the sheath, and may produce speedy death of the tendon itself. As the result of exposure, necrosis of a tendon at times takes place, attended with considerable suppuration, and not infrequently with grave pyæmic or septicæmic conditions.

The favorable or unfavorable issue of a case of open tendon-wound largely depends upon the treatment adopted, though affected of course by the existing constitutional state. Other things being equal, the danger is decidedly greater when the injury is of a tendon having a synovial sheath. Even a subcutaneous wound of such a tendon is likely to be followed by destructive inflammation, and hence tenotomy should in such cases be avoided. Apposition of the separated ends, if possible, is to be effected, or at least approximation as close as may be, and the wound of the overlying tissues should be closed if practicable, in order that primary union may perchance occur. Such a position of the parts is to be adopted as will best prevent movement of the damaged muscle, and this should be maintained by the use of fixed dressings, the plaster-of-Paris bandage being preferable to any other.

Of the propriety, not to say necessity, in many cases, of uniting the divided ends of a cut tendon by *sutures*, there cannot at the present day be much question, as far as recent wounds are concerned. Even if a considerable time has elapsed since the injury and cicatrization of the wound has taken place, if the functional impairment is great, the ends of the tendon should be sought for, and, when found and freshened, united by sutures, preferably of wire, since silk sets up too much irritation, and catgut melts down too soon. If the upper end of the tendon cannot be found, the lower end may be attached to a contiguous tendon, as has been several times done successfully, and if the lower end is fixed in the cicatrix, the upper may be also fastened into it, and voluntary movement of the supplied part thus regained, as occurred in Chassaignac's case more than a quarter of a century ago, and in B. Anger's much more recently. Tendon stitching has been successfully employed also in operations for the relief of talipes calcaneus, a portion of the elongated tendo Achillis being removed and its ends adjusted with sutures.

DISPLACEMENTS OF TENDONS.—As a result of sudden movements or extreme violence, a tendon may be forced out of its normal position, replacement occurring either spontaneously or by the aid of surgical interference. Thus in a certain proportion of cases of fracture of the lower end of the radius, the tendon of the extensor carpi ulnaris is believed by some to be thrown

out of its proper groove on the posterior surface of the head of the ulna; and the tendon of the long head of the biceps flexor cubiti has been frequently reported as displaced from the bicipital groove. But there is good reason for doubting the actual occurrence of either of these accidents.

There can, however, be no question that displacement of the peroneal tendons, especially that of the peroneus brevis from its bed behind the external malleolus, does take place, and that not so very seldom. Coming forward upon the malleolus, it can be readily felt, and slight manipulation will suffice to carry it back to its normal place. To retain it there, though, is a matter of much difficulty; of impossibility, indeed, in many if not in most cases. All that can be done is, after replacement, to apply a retentive bandage, preferably immovable or elastic, and keep the parts quiet for a number of weeks until reunion of the torn lateral ligaments or fascial investment shall have taken place, if this can be secured. Similar ease of restitution and difficulty of maintenance have been found to be the rule in the analogous displacement of the latissimus dorsi muscle from the inferior angle of the scapula.

INFLAMMATION OF THE SHEATHS OF TENDONS.—Inflammation of tendinous synovial sheaths (*tenosynovitis* or *theetitis*) is frequently met with, and may be either acute or chronic. Almost always, if not always, of traumatic origin, oftentimes the exciting cause is not a single severe bruise or wound, but long-continued slight irritations or tendinous movements, as in various sorts of manual occupations.

Acute Tenosynovitis.—In the acute form, not dependent upon an open wound, pain more or less severe is usually the first noticed symptom, such pain being limited to the region of the affected tendon, and aggravated upon movement. Swelling soon appears along the course of the tendon, which is most usually one of the radio-carpal extensors in the forearm, or one of the finger extensors in the neighborhood of the wrist, or one of the peroneals or flexors in close relation with the malleoli—much less frequently one of those crossing the anterior surface of the ankle. Occasionally the long head of the biceps flexor cubiti has been found to be the seat of the disease. Associated with the pain and swelling is the peculiar and characteristic crepitation, which may be both felt and heard, whence the name “crepitating tenosynovitis.” Differing from the sharp grating sound of the crepitus of broken bones, and from the “compressed bladder, half-filled with air” crackling of emphysema (though Lobstein thought that it was really emphysematous and due to an accumulation of gas in the synovial sheaths), the sound has been likened to that produced by the rustling of silk. This crepitation, due to the rubbing together of the exudation-lined walls of the synovial sac, ordinarily continues in the milder cases not more than a couple of weeks, diminishing in proportion as the fibrinous exudation is absorbed. In the severer cases it is likely to disappear earlier, being stopped by the separation of the inflamed walls by serous or purulent accumulations.

These more violent inflammations are ordinarily consequent upon severe contusions or open wounds of the sheath, as in amputations of the fingers, through the hand, or through the tarsus, less frequently in amputations of the toes. The symptoms are all strongly marked, the pain especially being very severe. Suppuration early takes place, either limited—there being sometimes two or more separated foci—or diffused, rapidly extending up the sheath and involving the connective-tissue planes of the forearm or leg. Very often there is lighted up destructive inflammation of the contiguous bones and joints, and, as shown by Bryant's case, even dangerous hemorrhage may be kept up by the presence of the necrosed tendon. The constitutional symptoms are pro-

portionately grave. If not properly and promptly treated, death of the tendon soon takes place, and not infrequently pyæmia is developed. At the best the recovery will be but imperfect, with more or less tendinous adhesion and consequent restriction of movement, and often ankylosis of the affected joints; marked deformity is likely to result in the severe cases, from loss of substance and cicatricial attachments.

Treatment.—The inflammation in the mild cases may generally be controlled by rest (best secured by immobilization of the part) and by pressure. Slightly stimulant applications are believed to be of service, but the tincture of iodine, which is ordinarily used, either does no good or positive harm, in that valuable time is wasted in its application. In its very commencement, the severer form of tenosynovitis may sometimes be arrested by the application of heat, either by fomentations or poultices, or by local depletion, much more often by compression, particularly when made with the elastic bandage, applied not only to the affected part but over a large extent of the limb. Thus used, the rubber bandage is for every reason much to be preferred to digital compression or ligation of the main artery, both of which have been resorted to. Failing by these measures to arrest the disease, as shown by the increase of pain and tension, the affected tendinous sheath should be freely opened; much more imperative is the use of the knife if suppuration has actually taken place, as indicated by aggravation of the local symptoms with an added throbbing and the occurrence of rigors. If one incision does not suffice to arrest the disease, others must be made, and the course of the inflammation must be followed up and suppuration “headed off” if possible. The affected part should be elevated, and hot applications should be continuously employed. If the tendon dies, it should be speedily removed, especially if there is much bleeding from the wound.

The constitutional treatment must of course be that which will relieve pain and sustain strength. Opium is always indicated, and alcohol is usually demanded sooner or later in other than the mildest cases. Pyæmia, if it develops, must be treated in the usual way. Destructive inflammation of the bones and joints may render amputation necessary.

Chronic Tenosynovitis.—The chronic variety of tenosynovitis, which affects much the same tendons as the acute, may be either consecutive to the former, or may be chronic from the start. As its name indicates, it is of long duration, and its symptoms are not severe. But little pain is experienced except when the part is struck, and when spontaneous pain is present it has been observed to be of intermittent character, and, in the majority of cases, in tenosynovitis of the upper extremities. Rarely getting well when left to itself, this form of the disease is very apt to give rise to, or at least to be associated with, inflammation of neighboring bones and joints. There seems to be good reason for believing that in some cases of fungous arthritis, the disease has originated in the synovial sheaths of tendons crossing the joint.

Swelling is the especial symptom of this chronic tenosynovitis, following at first the course of the tendon, of elongated shape, changing its position slightly when the tendon is acted upon by muscular contraction, movable from side to side, and, after a time, involving the neighboring parts, which become more or less thoroughly matted together. The synovial sac is filled with fungous, highly vascular granulations of varying firmness, whence the name fungous tenosynovitis. Sooner or later, spontaneously or as the result of an opening of the sheath, mushroom-like masses are likely to show themselves externally, when the case may be easily mistaken for one of malignant disease. It occurs most often in the earlier years of mature life, and in men

rather than in women—as might naturally be expected, since it is of traumatic origin.

Treatment, other than operative, is seldom of any benefit. Rest, massage, blisters, sulphur-baths, and pressure, are occasionally of advantage, and irritant injections at times cause a disappearance in part, or wholly, of the granulations, though usually all of these methods of treatment result only in failure. If the disease has not progressed so far as to necessitate amputation, or if the tendon itself is not so buried and fused in the fungous masses that it cannot be dissected out, these masses must be thoroughly cut or scraped away; with antiseptic precautions, such operations are attended with but little risk to either life or limb. Partial removal of the diseased tissue is sure to be followed by early re-development of the trouble; consequently, if amputation is not required, and if complete extirpation cannot be effected, a simple compressing bandage should be worn, and further interference abstained from.

PARONYCHIA AND FELON.—As the result of injury, often of slight degree, such as a pinch, a scratch, or a needle prick, affecting a finger, and especially the palmar surface of a distal division, inflammation is developed, located outside the investing deep fascia, in the tendinous sheath, or in the periosteum and phalanx—or, as is more usually the case, wherever originating, involving all the parts through extension by contiguity, as also by direct continuity, since the layers of tissue from bone to skin are here united by fibrous threads passing through the interstices of the cribrillated periosteum, up and into the under surface of the derm. This anatomical constitution, which is peculiar to the region under consideration, however advantageous in limiting the movement of the skin and thus insuring accuracy of touch, is very favorable to the rapid extension of inflammation, and is unquestionably the cause of the frequent severe results that follow the slight injuries already referred to. Wherever situated, and usually it is primarily in the superficial fascia, the pain attending these finger inflammations is very severe, the tension decided, and the swelling great. Suppuration early takes place, and the pus may be located superficially, as it is in the milder cases, or about and beneath the sheath of the tendon. When the latter is involved, the tenosynovitis rapidly extends upwards, and if not arrested by treatment passes along the entire length of the sheath, to near the metacarpophalangeal articulation in the index, middle, and ring fingers, into the palmar subfascial bursa when the little finger is the seat of the disease, and above the wrist when the thumb is the part affected. Such extension is indicated by the degree and location of the pain, by swelling over the course of the tendon, by inflammatory changes in the over-lying skin, and by constitutional disturbances of high grade. Great increase in the severity of the symptoms, with throbbing, mark the formation of pus.

Unless promptly relieved, and not always even then, necrosis of the tendon is very apt to follow, and if the diseased part is saved at all, it is so in only a very damaged condition. Periostitis and osteitis occur in a large proportion of cases, with frequent destruction of the phalanx, even when proper treatment is early instituted and thoroughly carried out. Oftentimes, in consequence, we must assume, of some outside influence, atmospheric or otherwise, these violent and destructive finger inflammations occur epidemically.

In the very commencement of the affection, the continued application of hot water, painting with the tincture of iodine, the use of a blister, or compression, best made by the elastic bandage, may arrest the inflammation. If such measures fail, as they are very apt to do, a full, free, deep incision must be made—such an incision not only relieving tension and permitting the escape of pus; if formed, but being of service also by the local depletion pro-

duced. If necessary for the evacuation of pus, the sheath of the tendon must be opened higher up, and free drainage must be secured. When there is resulting necrosis of the phalanx, and this will occur in a considerable proportion of cases in spite of all that can be done, ample time should be given for the spontaneous separation of the sequestrum, which can then be easily removed. Very often the epiphysis will be found healthy, so that the phalangeal articulation need not be opened. Simple extraction of the dead bone is much to be preferred to amputation, as by the filling in and contraction of the soft parts, an useful substitute for the original finger-end will remain.

PALMAR ABSCESS.—As the result usually of the extension of the previously described tenosynovitis of the digital flexors, but sometimes as the consequence of long-continued irritation of a limited portion of the skin of the palm of the hand, with the formation of small callosities such as are frequent with various sorts of artisans, there is developed an acute inflammation of the great bursal pouch under cover of the palmar fascia. When the primary inflammation of the tendinous synovial sac is located on the index, middle, or ring finger, it is usually arrested spontaneously for a time at the metacarpophalangeal articulation, in consequence of the termination of the sac at that level. After a little delay, however, the barrier intervening between the tendinous sheath and the great pouch above, if they come in close contact with each other, is broken down; or, if they are more widely separated, as they often are, the inflammation is propagated along the interposed connective tissue, so that, whatever the anatomical arrangement, before very long the palmar sac is involved. If the little finger is the seat of the original trouble, the morbid action is usually led directly up to the palm of the hand, as the flexor-sheath of that finger ordinarily communicates with the subfascial pouch. Since the flexor-sheath of the thumb passes up separately on the palmar surface of the forearm, where it either opens into the continuation of the palmar sac above the wrist, or terminates in close relation with it, separated merely by a thin wall which may readily be broken through, it is only by downward progress, under and below the annular ligament, that central palmar inflammation and resulting abscess can arise from lesion originally confined to the thumb. Cases, however, may at times be met with in which the course of the disease proves that the usual anatomical arrangement does not exist; and this is not so much to be wondered at since, as has been said, “bursal sheaths are parts of great variability and inconstancy, and they early become changed in pathological conditions.”

Symptoms.—Wherever originating, and however propagated to the subfascial space, acute palmar bursitis is indicated by great pain, by marked swelling, the natural concavity of the palm being changed into a convexity, by an œdematous and discolored condition of the skin, associated not infrequently with a superficial sub-epidermal suppuration, by high fever and decided general prostration. Suppuration quickly occurs, the pus-formation causing generally the usual and characteristic rigors. In the advanced stages of palmar abscess an error in *diagnosis* can hardly be made, but at an early period the nature of the disease may, and often does, escape recognition, the inflammation being believed to be but superficially located.

The *prognosis*, though much affected by treatment, is always grave, for seldom is the inflammation recovered from, be it never so slight or never so well treated, without some impairment of the functional integrity of the parts. When neglected or improperly treated, the danger both to the part and to life itself is very great, the patient, if recovering at all, doing so only after the lapse of much time, and then with a badly damaged hand, permanent flexion of the fingers in greater or less degree being ordinarily met with. Not

seldom does it happen that the inflammation, spreading from the palmar bursæ to the carpal and carpo-metacarpal articulations, completely destroys these, and at the same time produces necrosis of the bones entering into their formation, so that not infrequently amputation through the forearm is ultimately rendered necessary. Extension of the inflammation along the muscular planes of the forearm to the elbow, and thence along those of the arm even to the shoulder, frequently takes place, terminating favorably only after a protracted siege, and oftentimes causing death of the part if not of the patient. Occasionally, and not so very seldom either, as a result of suppuration in the palm or in the forearm, opening of a palmar arch or of one or more of the main vessels of the forearm occurs, the resulting hemorrhage necessitating an extensive dissection in order that its source may be ascertained, or, as sometimes happens, amputation of the extremity. Acute gangrene, quickly proving fatal, has been seen in connection with palmar abscess, and septicæmia is frequently observed.

Treatment.—The treatment to be adopted is as clearly defined as is the affection itself. The essential point is the early opening of the abscess and the securing of thorough drainage, due care, of course, being taken to avoid wounding important bloodvessels and nerves. If the first incision fails to put a stop to the extension of the disease, and burrowing of matter continues, subsequent openings must be made, in the palm of the hand, above the annular ligament, or anywhere in the forearm where pus is evidently accumulated. Anodynes, stimulants, and a general supporting treatment will be required, according to the circumstances of the individual case. Very favorable reports have of late years been furnished by numerous surgeons of the value of the antiseptic method in the treatment of these palmar abscesses, as respects both their evacuation and the prevention of troublesome and dangerous sequelæ.

GANGLION.—Serous cysts or, as they are usually called, *ganglia*, are often met with in connection with tendons, especially the extensors of the fingers (those of the extensor communis and extensor indicis particularly) and those of the toes; and by their presence they give rise to deformity, pain, and weakness. The ganglia which are so frequently seen upon the back of the wrist or hand, while generally but pouchings of the sheaths of the tendons, may be due to protrusions of the synovial membrane of the radio-carpal or carpal articulations, and much more rarely to serous distension of original or secondary mucous bursæ. The tendo-vaginal herniæ are most likely to appear just below or above the constricting posterior annular ligament, but the protrusions may be through normal or abnormal openings at other points. Frequently they appear suddenly, in consequence of exertion with associated twisting of the hand, but at times they are developed very slowly, by simple enlargement of the natural dilatations of the “end openings” in immediate relation with the annular ligament. The arthritic ganglia may be rapidly produced as the result of strain and twist, or slowly by enlargement of the “synoviparous crypts” of Gosselin. In the former case it is easy to determine the connection with the main synovial sac, since pressure suffices to press out the fluid, which more or less quickly returns according as the orifice of communication is large or small.

The *diagnosis* of ganglion is readily made; the history of its appearance, its location, its cystic contents, and the absence of inflammation in the overlying skin, at once indicate its nature.

Ganglia may be *treated* by rupture, by puncture, by subcutaneous section, by open division, or by partial or complete removal. Local applications and pressure at times cause a disappearance of the swelling, but thus effected the

removal is seldom a permanent one. In tense, thin- or moderately thick-walled cysts, pressure with the thumbs will suffice to burst them, rapid absorption of the effused contents will follow, and by the after-application of pressure a cure may be effected, though recurrence is likely to take place. In the case of firmer ganglia, forcible rupture, as, for instance, by striking them with a heavy book or weight, is not to be advised, on account of the likelihood of exciting severe inflammation. Subcutaneous section and laceration of the sac with a knife or spear-pointed needle is much to be preferred. The more radical operations of excision or open division have until recently been but little favored, on account of the great danger of exciting acute tenosynovitis, but now it is claimed that by the observance of strict antiseptic precautions all such risk may be avoided, and that in free incision with "thorough drainage and the promotion of the development of a granulation tissue" we have the best and safest method of permanently curing all forms of ganglia.

TUMORS OF TENDONS.—These, like tumors of muscles, though occasionally originating from the tendon itself or its investing sheath, in the great majority of cases come from without, and by extension include or invade the tendon secondarily. They may be either cystic or solid, benign or malignant; due to some unknown cause, or directly consequent upon a constitutional affection, most generally syphilis. Ordinarily the tendon-involvement neither adds to the difficulty of diagnosis nor to the gravity of the case, except as it increases functional impairment, for the relief of which operative interference may be rendered necessary. *Cystic* tumors have already been considered. *Syphilitic* affections present much the same phenomena as when located in the bellies of the muscles, and are to be treated in a similar manner. At times a small and slowly-developing *fibroma* is found upon a tendon or its sheath, for instance, a finger-flexor, which by its presence may so interfere with movement as to make it advisable to remove the part or dissect off the growth. As a result of the latter procedure, tenosynovitis not seldom occurs; and though the likelihood of this happening may be materially lessened by the employment of the antiseptic method, still the danger is sufficiently great to compel a postponement of the operation until it is imperatively demanded.

OSSIFICATION OF TENDONS.—Bone-deposit of limited extent is frequently found in tendons, the ossification usually affecting the insertion-end. Met with as a consequence of frequently repeated slight blows or pressure (as in the so-called "exercise bones"), it may be due to nutritive change resulting from general disease, as in the subjects of rheumatoid arthritis, or may be consequent upon contiguous joint- or bone-injury, as in cases of old unreduced dislocations, or of fractures in which union has slowly taken place, and has been associated with the production of a large amount of callus. The diagnosis of bone-transformation is usually easy when the tendon is so superficial as to be readily felt. For the relief of the disability, if such there be, arising from the presence of these bony masses, nothing can be done except by operative interference, and this is but very rarely required or advisable.

INJURIES AND DISEASES OF FASCIÆ.

Investing and compressing the great muscular masses of the body, separating them from the superficial structures, and isolating them one from another, are found fascial sheets and aponeuroses, which have a positive surgical as

well as anatomical interest. Very scantily supplied with bloodvessels, and nourished largely by imbibition, they are in themselves but little prone to inflammation (which, however, does at times occur, producing effects to be presently considered), but are, when inter-muscular, easily affected by contiguous disease, which, cutting off the blood supply, causes necrosis, resulting in the separation of extensive sloughs.

The denser and more external layers of fascia, by hindering the distension of inflamed structures, greatly aggravate the attendant pain, and when suppuration has occurred, may very decidedly increase the difficulty of spontaneous evacuation of the pus, and the dangers consequent upon its presence, favoring, or actually compelling, burrowing of matter among the neighboring tissues, or its diversion towards more important parts. Thus, a sub-aponeurotic inflammation of the *head* will, if left to itself, spread widely under cover of the fascia, and cause much and dangerous destruction of tissue. Because of the overlying fascia, the swelling of a *parotid* inflammation may produce even fatal compression of the great vessels of this region, and the resulting pus may be compelled to find an outlet through the ear or the mouth, or to infiltrate the neck. Again, pus in the *episternal* pocket much more readily makes its way inwards and downwards to the anterior mediastinal space than through the external sheet of the deep fascia to the surface. As we have already seen, deep-seated inflammations of the *forearm* rapidly extend along the intermuscular septa towards and beyond the elbow, and extensive suppuration and sloughing are likely to occur; and a similar course is often taken by sub-aponeurotic phlegmons of the *leg*. At times pus is thus directed in a favorable rather than an unfavorable way, as in *caries of the dorso-lumbar vertebrae*, when by the firm sheath of the *psoas* it is led downwards towards the groin, or by the lumbar fascia outwards and backwards to the flank.

Accurate knowledge, therefore, of the position and attachments of fasciæ will enable the surgeon to foreknow the probable course of an inflammation, and will lead to an early opening of the resulting abscess, in order that the destruction of tissue may, as far as possible, be limited, and that local and constitutional dangers may be averted.

REPAIR OF FASCIAL WOUNDS.—Because of the small number of nutrient vessels distributed to fasciæ, as already mentioned, primary union of their wounds cannot be effected—a fact to be borne in mind when one of the dense external aponeuroses has been incised or lacerated.

CONTRACTURES OF FASCIAE.—As the result of chronic inflammation of low grade, resulting either from diathetic conditions, or from repeated though not severe injuries, shortening of a fascia at times takes place, with consequent deformity, more or less marked according to circumstances. Such contractures, as also the similar fascial conditions resulting from diseases of contained or covered structures (bones, ligaments or muscles), become important in direct proportion to their extent and the functional value of the parts affected. When the external portion of the *fascia lata* is thus diseased, progressive shortening may go on until the leg is strongly and permanently flexed upon the thigh; in which case nothing but an extensive division of the tense band will suffice for the removal of the deformity; and even then the relief may be but temporary, recontraction often taking place, notwithstanding the faithful use of mechanical appliances.

Dupuytren's Finger Contraction.—The most important, because the most frequent, of these fascial contractures is, undoubtedly, that of the palmar fascia, producing the so-called “Dupuytren's finger contraction.” This

malady, which has long occupied the attention of surgeons, has very rarely been noticed in young subjects, is seldom seen in women, and, though a different opinion has been held by many, is more frequently met with in individuals of the middle and higher classes than among hand-laborers. Usually regarded as of traumatic origin, and as consequent upon frequently repeated slight irritations, as, for instance, the pressure of a tool handle, such a causation may well be questioned if it is most often a disease of those whose hands are not subjected to habitual pressure; and its frequent association with chronic dry arthritis makes it possible, not to say probable, that it is but an expression of a rheumatic or gouty diathesis. Ordinarily it affects but a single finger—either the ring or little finger—and never the thumb, for the simple reason, of course, that that digit is not connected with the true palmar fascia. Slowly developing, there is a steadily progressive drawing down of the finger towards the palm, the first phalanx only, as a rule, being flexed, though at times the second is so too. In the distal part of the palm, besides a more or less wide-spread thickening of the skin, there is to be seen and felt a well-defined, hard cord, thrown out in strong relief, following the course of the flexor tendon, most pronounced over the line of the metacarpophalangeal junction, and extending into the side rather than the anterior surface of the finger. Adhesions of greater or less extent will commonly be formed, sooner or later, between the fascia and skin.

That the abnormal flexion of the finger is not due to muscular contraction, is shown by the non-involvement of all its divisions, but only of the first or, at most, of the first and second; and also by the fact that no relaxation takes place under full anæsthesia. That it is the overlying fascia and not the tendon that is contracted, is proved by the healthy state of the latter found upon dissection, by the free and full movements of the finger that can be effected as soon as the tense fascial band is divided, and by the fact that the greatest elevation of the indurated cord is evidently over the metacarpophalangeal articulation, just where the tendon is most firmly fastened down. Repeated careful examinations have demonstrated that it is the digital prolongations of the palmar fascia that are primarily affected, the disease in time progressing up along the fascia to a variable distance, and occasionally, as shown by Adams, downwards along the lateral insertions to the second phalanx, in which case this part of the finger becomes contracted along with the first.

If left to themselves, these "finger-contractions" go on from bad to worse, and can only terminate in marked deformity and impairment of the usefulness of the hand. Internal medication, local applications, and mechanical appliances are of little or no value. Division of the band must be effected if relief is to be afforded; and this division may be either by open wound or subcutaneous, at one point or at many. If by *open wound*, the incision may be transverse and through the entire thickness of the skin and fascia—the method of Dupuytren—or longitudinal through the skin and transverse through the fascia, as practised by Goyrand; or there may be a V-shaped incision of the skin, with absolute removal of the contracted fascia, as in the more modern operation of Busch, the base of the flap corresponding to the line of the great transverse crease of the hand, and the apex extending to the highest point of the contraction. This flap may be left entirely to itself, or, after it has fully retracted, its edges may be stitched to the adjacent skin. No stretching out of the finger is to be attempted, either mechanically or by passive movement, until granulation is well established, and the operation and after-treatment should be conducted antiseptically. Though very favorable reports have been given of the results of "Busch's method," yet, in common with all the other operations by open wound, it must have in it an

element of danger, and there must be some probability of cicatricial reproduction of the flexion.

The idea of *subcutaneous section* of the contracted bands goes back certainly as far as the time of Sir Astley Cooper, and many surgeons have put it in practice with more or less satisfactory results. Quite recently Mr. Wm. Adams has very strongly presented the merits of this method of procedure, and has shown that, in his hands at least, it is at once easy, safe, and successful. He directs that a very small, straight-edged knife, smaller than the ordinary tenotome, shall be introduced just above and below where the skin is firmly adherent to the band, and the contracted tissue divided from above downwards; and if, as is often the case, these sections are insufficient to completely free the finger, other similar divisions are to be made wherever required—as many as, and no more than, will suffice to permit of full and perfect extension of the finger. Absolute rest of the hand and extended fingers is to be secured by the application of a light metallic splint, and the dressing is not to be disturbed until the fourth day. The splint is to be kept on night and day for two or three weeks, and afterwards at night only for three or four weeks longer, movement of the fingers being permitted during the day. Cases thus treated have so completely recovered that but slight traces have remained of either disease or operation, and the functional use of the hand and fingers has become and remained practically perfect.

INJURIES AND SURGICAL DISEASES OF THE LYMPHATICS.

BY

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WOUNDS OF LYMPHATICS AND LYMPHATIC GLANDS.

THE enormous number of lymphatics which are distributed to every part of the body, in far greater number than the bloodvessels, renders it evident that in every wound or contusion in which bloodvessels are involved, lymphatics are involved also. The result is an outpouring of blood and lymph, and the outpoured lymph becomes ultimately developed into the bond of union whereby reparation of the injured tissue chiefly comes about. We notice that at first the flow from the wound is of both blood and lymph, and after a while a flow of clear lymph, which becomes organized. It does sometimes happen, even when there is no pathological change in the lymphatics, that a persistent flow of lymph may follow an injury, constituting what is termed lymphorrhœa or lymphorrhagia; and this traumatic form generally follows wounds of the thoracic duct, larger lymphatic vessels, or glands. In all wounds which involve large muscular surfaces, a considerable lymph flow occurs, owing to the rich network of vessels, by which, as demonstrated by Ludwig, the muscles are invested.

WOUNDS OF THE THORACIC DUCT.—Cases of wounds of the thoracic duct have been placed on record, and it is possible that they may be of more frequent occurrence than is supposed, even if we set aside the fact of direct wound such as inflicted by a gunshot or puncture; rupture of the duct may result from a fall or twist, or from a growth, which may obliterate its lumen. From the cases placed on record, it would not seem that the lymph extravasation is necessarily at once, or, indeed, certainly fatal; and experiments and post-mortem records show us that, after obliteration of the duct, the circulation of the lymph has been restored by the collateral lymphatics and right lymphatic trunk.

WOUNDS OF LARGE LYMPHATIC TRUNKS.—The chief interest attached to these is the resulting lymphorrhœa, and the oft-quoted case recorded by Hewson sufficiently illustrates the condition. This was the case of "a butcher, who, by letting his knife fall upon his shin, cut some of the large lymphatic vessels which pass over the tibia; from this wound there flowed a considerable quantity of clear lymph, which, being confined by the dressings, jellied, and then appeared at first sight like a whitish fungus, but being loose could

be removed by a spatula." This may be regarded as the typical condition resulting from a wound of a large superficial lymph trunk. Lymphorrhagia may follow wounds of the glands, or may be the result of a surgical operation, such as opening a bubo. The lymphorrhœa following dilatation of the lymphatics will be referred to hereafter.

Treatment.—This consists of pressure applied to the peripheral portion of the divided vessels, by the application of a suitable compress, such as a pad of lint soaked in a lotion of carbolic acid (1 in 40) and retained by a bandage. Any mismanagement may readily lead to the formation of a fistula, or to a troublesome lymphorrhœa.

LYMPHANGELITIS.

(Synonyms: *Lymphangioitis* ; *Angeioleucitis*.)

We may conveniently consider the subject of lymphangitis under two heads: simple and septic. Simple lymphangitis (which we may regard as *reticular* and *tubular*) is most frequently of traumatic origin, although the idiopathic form occurs occasionally. The traumatic form is of the reticular variety, and although usually developed in the immediate vicinity of an injury, may show itself at some distance from such a lesion.

RETICULAR LYMPHANGELITIS.—This form has a greater tendency to affect the external than the internal parts of the vessels, and can be most conveniently instanced in such cases as simple paronychia, erythema, or erythema nodosum, this latter being a reticular lymphangitis with an added lymphatic œdema. Curnow calls attention to this connection between erythema nodosum and lymphangitis, and instances a case in which there was such extensive effusion into the knee-joint that the case was supposed to be one of articular rheumatism. With regard to the form seen in paronychia, which may or may not be due to the introduction of a septic agent, and is frequently met with in anæmic seamstresses, the locality is almost invariably a terminal phalanx. It presents the usual characteristics of pain, heat, redness, and swelling—possibly, but not always, running on to suppuration, and that suppuration being subcuticular—red lines perhaps indicating the invasion of the superficial ducts, and neighboring glands swelling and becoming painful. The duration is usually very short, and in the earlier stages disinfection of the spot, or, if necessary, incision, with ordinary therapeutical agents and fresh air, soon effects a cure.

A variety, called the "wandering" by Curnow, is occasionally met with, unassociated with any breach of the skin, and due to frequent contact with septic tissues. Usually commencing on the dorsum of the hand, it "extends upwards by the successive appearance of multiple patches, occasionally but not always connected with wavy lines. Each patch lasts but a few days, and is quickly followed by another. They are extremely painful, and around them is a slight œdema. The corresponding glands are always enlarged and painful, even when there is no secondary implication of the main lymphatic trunk." I have had occasion to observe this condition since the appearance of the lectures in which the above quotation occurs.¹

The superficial inflammation of lymphatics occurring in patches, would seem to correspond with the locality of adjacent anastomoses. This, from the fact of the patches being often unmarked by the wavy lines, may cause the nature of the condition to be overlooked. The deep form of reticular

¹ Lancet, April, 1879. Gulstonian Lectures.

lymphangeitis is a matter of which we know but little; it no doubt often occurs in association with diffuse cellulitis.

TUBULAR LYMPHANGEITIS.—Inflammation of the lymphatic ducts is characterized by wavy or, perhaps, straight red lines, hard and gritty to the feel, passing from the seat of injury, abrasion, or puncture, to the nearest lymphatic gland, which is swollen and tender; œdema of the tissues occurs, the course of these tracks is acutely painful, and there is considerable fever and high temperature.¹ The statement that the lymphangeitis is limited by the nearest lymphatic gland is certainly erroneous, and many opposing facts have been observed. Curnow (Gulstonian Lectures) quotes a case under his own observation in which septic material was absorbed by a wound, and the supra-condyloid gland became inflamed, and subsequently the axillary glands; and he considers that this condition depends greatly on the nature and intensity of action of the exciting cause.

Various pathological changes take place in the lymph, lymphatics, and surrounding cellular tissue. The *lymph*, instead of being transparent, becomes opaque and full of cells; coagula, or thrombi, perhaps form; and the vessel becomes occluded. These thrombi are pinkish in color, and not as firm as venous thrombi. They generally form in the immediate neighborhood of the valves. Adherent to the wall of the vessel, they block or may obliterate its lumen, when a collateral circulation is set up. They may break down and become puriform. Dilatation occurs in the *lymphatics* themselves. They become thickened, the endothelium disappears, and the internal coat becomes opaque and uneven. The *cellular tissue* becomes œdematous (lymphatic œdema), owing to the exudation from the vessels, which may either resolve, become sclerosed, or suppurate. Bradley mentions that the chief danger in tubular lymphangeitis lies in the connective-tissue changes, and instances a case under his own care,² of cellulitis accompanying lymphangeitis of the neck, where a brawny œdematous collar encircled the part. The constitutional symptoms and urgent dyspnoea suggested tracheotomy. The tissues were, however, incised in the mesian line, and a director passed freely into the cellular tissue on either side, with the good result of a subsequent copious flow of pus, and ultimate recovery. Cellulitis may occur, dependent on lymphangeitis; and not infrequently arthritis, running on to suppuration. This latter complication has been particularly studied by Verneuil;³ and a very similar case to that recorded by Bradley⁴ was under my own observation, in which acute arthritis of the knee-joint followed an injury to the foot. The joint was opened antiseptically, a large amount of pus was evacuated, and the patient, a child, did perfectly well, regaining complete movement of the articulation.

Lymphangeitis may however succeed arthritis, more especially in the case of the knee-joint, and must be regarded as of extreme moment when suppuration supervenes.

The fact of suppuration does not necessarily imply a systemic sepsis, unless the pus contains germs, micrococci, or bacteria; and here indeed is the true difference between simple and septic lymphangeitis, and between non-infective and erysipelatous inflammation.

Diagnosis.—Ordinarily, simple lymphangeitis is readily diagnosed, phlebitis and erysipelas being the diseases most closely associated with it in appearance. We always have, in lymphangeitis, a temperature far higher than that in

¹ In certain cases of septic lymphangeitis, no glandular enlargement or pain occurs, while at the same time destructive suppuration is developed in the synovial sacs in the fingers and palm, which we must certainly regard as lymphatic réseaux.

² Bradley, *Injuries and Diseases of the Lymphatic System*, p. 64. London, 1879.

³ *Revue Mensuelle de Médecine et de Chirurgie*, t. ii. pp. 816–821. Paris, 1878.

⁴ *Op. cit.*

phlebitis; in erysipelas the redness is general, and there is absence of contagium.

The *prognosis* is usually favorable, with the exception of the occurrence of suppuration in the arthritic condition, which is a very serious complication in the septic form of the disease.

Treatment.—This must be both local and general: local so far as to reduce pain in the acute stage by the use of fomentations of poppy heads, and the application of belladonna and glycerine in equal parts, painted all over the suffering tissues.¹ If these are highly swollen and œdematous, perhaps bandaging with fine elastic webbing may be of service, and Bradley speaks highly of “massage;” but personally I have had no experience of this method.²

Constitutionally iron is invaluable, and perhaps the most readily assimilable form is the chloride, which may be given in the form of the tincture, x-xxx m. for a dose.

SEPTIC LYMPHANGELITIS.—The introduction of micrococci and bacteria into the open-mouthed lymphatic capillaries, is undoubtedly the cause of septic lymphangitis, which, although a condition common to many diseases, has its origin from different infections; as for example, in vaccinia, smallpox, diphtheria, erysipelas, glanders, etc.³ Septic lymphangitis is the precursor of septicæmia.

The most frequent form of septic lymphangitis is that following dissection wounds. The inoculation of virus from a dead body is not of necessity through a scratch or a cut, but in many instances undoubtedly by endosmosis; and it is remarkable how different, as to mildness or severity, the results of such an inoculation may be, this depending upon the condition of the poisoned individual, upon the nature of the poison, and upon the quantity of poison absorbed. Thus, an inoculation which in one individual may cause a simple lymphangitis, in a second may be fatal. The atmosphere in which the poisoning takes place, and the previous state of health of the recipient, must also have a marked influence on his general condition. This has been frequently observed, especially in dissecting or post-mortem rooms, in men infected from the same body; and in one case in particular, of four men thus infected, one died from pyæmia, two were most seriously ill, whilst the fourth escaped with little or no further trouble than a simple lymphangitis, the mischief being confined to the lymphatic system. In the other cases, we have an illustration of Burdon Sanderson’s “pyrogenic” condition, in which the gravity of the septicæmia is in direct proportion to the amount of septic material introduced.

It is impossible to determine at what period a body becomes infectious; and as regards the changes which must occur, Dr. Roberts⁴ remarks, that “under a certain occurrence of conditions in and about the wound (*if there be one*), a mortification takes place in the vital endowments of the septic organism, whereby it acquires a parasitic habit which enables it to breed in tissues of degraded vitality, or even in the healthy tissues, and in this way to produce the infective endemic pyrexia which we sometimes witness in the wards of our large hospitals.” (See Erysipelas.) Bradley, in a lecture on septicæmia (May, 1876), gives as examples the following graphically described

¹ I can testify from personal experience that this remedy acts like a charm.

² The early application of Lister’s dressing has, in several cases under my care, speedily cut short what might have been serious consequences, and in the suppurative stage the injection of a three per cent. solution of carbolic acid into the neighboring tissues, has been most efficacious.

³ As erysipelas and glanders have been separately treated of, neither is described in this article.

⁴ On “contagium vivum.” British Medical Journal, 1877.

cases of lymphangitis, illustrating the difference between two forms of septic inoculation from dissection wounds. The first is from his own personal experience, and accurately describes what many of us have suffered.

In December, 1871, I pricked my finger one day while dissecting, but took no notice of the puncture at the time; in the night following the accident I awoke with violent pain and throbbing in the finger and up the arm. I tossed about till daybreak, when I saw two thin, red streaks on my arm, running from the finger to the elbow. The pain was extreme, thirst excessive. Temp. 102° . A tender, enlarged gland could be felt just above the inner condyle. During the day the pain and red line extended up to the axilla; there a second tender and swollen gland made its appearance. The symptoms deepened in severity for the next twenty-four hours, when fluctuation could be detected in the axillary gland. An incision evacuated half an ounce of pus, and somewhat relieved the pain, which, however, still continued severe. I had two or three rigors during the day, and vomited several times. On the third day I was decidedly easier, the red lines were fading, and both lymphatic-vessel and gland tenderness markedly subsided. The fourth day I was convalescent.

The second case was as follows:—

W. S., aged 44, pricked his thumb while dissecting a tiger for the museum, and two days afterwards began to suffer pain at the seat of injury. On the fourth day he called to see me, when I found a small quantity of thin fluid discharging at the root of the thumb nail. The lymphatics were perceptibly affected, skin cold, tongue dry, pulse 100, but, perhaps, the most intolerable symptom was the intense mental depression. I freely incised the thumb and sent him home to bed; this was on August 22, 1875. From this time his general condition grew worse until the 26th, when an ill-defined, or rather an undefined, abscess appeared in the cellular tissue of the arm. On this being opened, several ounces of pus were discharged, which lay loosely in the tissues, unconfined by any limiting membrane. Each day fresh abscesses of the same diffuent character appeared on the chest, abdomen, legs, and feet. He was very restless, and passed gradually from a condition of prostration into one of muttering delirium, which ended in death on September 11, twenty-four days after the reception of the poison.

To these cases might be added that of a London physician who died four days after the reception of a prick from a needle, in sewing up the abdomen after a post-mortem examination. In the case of a colleague, without any external wound, subpectoral suppuration occurred within a day of feeling unwell, diffuse suppuration in the axilla and lateral pectoral region ensued, with some pleurisy, and intense depression. He recovered, after free incisions, drainage, and removal to fresh country air, with the singular complication of partial paralysis of the serratus magnus muscle, owing to the implication of the nerve of Bell in the inflammatory process. Recovery was, however, complete, and the muscle resumed its normal functions.

The above quoted cases illustrate the fact that the development of symptoms in septic lymphangitis is often slow, possibly owing to the slow nature of the lymphatic circulation, as may be instanced in syphilis, in some cases, where weeks may elapse between the appearance of the primary lesion and that of general symptoms; on the other hand, the writer has seen cases of syphilis where severe secondary symptoms occurred within one week of connection. According to some, the so-called gonorrhœal rheumatism is a septic lymphangitis accompanying gonorrhœa (or subsequent to it), having, in strumous subjects, an undoubted tendency to suppuration.

UTERINE LYMPHANGEITIS.—Injury to the mucous lining of the uterus, generally puerperal, will originate a lymphangitis of great severity, rapidly extending to the pelvic cellular tissue; although the septic material is as frequently introduced during labor, either by the infected fingers of an attendant, or by the atmosphere in which labor takes place. Recognizing the peritoneum

in its relation to the lymphatic system, we can readily understand how disposed it is to lymphatic infection, and that diffuse peritonitis rapidly follows such infection from various sources.

Puerperal peritonitis, like lymphangitis, may be simple or septic (pyæmic). The simple form is a local inflammation, owing to traumatic causes during delivery, is non-contagious, and not invariably fatal. In the septic form "the process extends or may be traced, anatomically, through the lymphatics which convey the material they take up to the blood, and in this way excite inflammatory processes in the large lymph spaces, and more particularly the peritoneum . . . and is to be regarded as an accidental disease of a wound, a pyæmic disease, in which the septic matter is first taken up by the lymphatics and conveyed onward by them; on the blood taking up the putrid (bacteric) material by the lymph vessels, there arises a general infection—an actual septicæmia." (Bauer.)¹

Curnow² remarks that,

"Uterine lymphangitis has been generally confounded with uterine phlebitis. In puerperal cases the two affections may exist side by side, but they can be easily distinguished. The cavities filled with pus in the uterine tissue in such cases are frequently lymphatic ampullæ, and not true abscesses. This is shown by the seat of the vessels, the smooth wall of the cavity, and the fact that the pus is quite white, or cream-colored, without any admixture of blood. Indications of valves in the cavity, and the absence of metastatic abscesses in the lungs and liver, as well as the extension of the disease to the adjacent glands, prove that the lymphatic system may be quite as much involved, if not more so, than the venous. In cases of so-called peri-uterine cellulitis and pelvic abscess, the following is frequently the sequence of the phenomena. In the first place there is a wound of the uterine mucous surface, engorgement, and inflammation of the lymph sinuses, leading to the formation of pus, and extension, either direct or by the cellular tissue, to the peritoneum. The inflammatory exudation is particularly noticeable where the cellular tissue is abundant—viz., in the broad ligaments and around the vaginal cul-de-sac. It may spread to the iliac fossæ and even to the lumbar region. In all these situations the lymphatics are very numerous. Sometimes the ovary is involved in the suppuration, and this is explained when we consider that the body of the uterus and the ovaries have a common lymphatic system. Peri-uterine cellulitis is really often a peri-uterine lymphangitis with infiltration into the surrounding connective tissue, and corresponds exactly to some cases of lymphangitis in the extremities. It may, of course, extend to the peritoneum, and undoubtedly there are many cases of primary pelvic peritonitis."

With regard to the *treatment* of septic *uterine* lymphangitis, there is little to be said; it is invariably fatal, and we can merely add that strict antisepticity must be adopted as a prophylactic. As regards the general treatment of septic lymphangitis, however, opium or turpentine stupes are of great value locally, in subduing pain, and perhaps the injection as a germicide of a saturated solution of carbolic acid may be of service; but the most valuable remedies are fresh air, quinine,³ opium,⁴ iron, and ammonia, with the antiseptic opening of abscesses as they occur.

The strength must be supported by the use of beef-tea, brandy and egg mixture, and other stimulants, so regulated as the condition of the patient suggests.

¹ Bradley, op. cit., pp. 90-1.

² Gulstonian Lectures, 1879.

³ In doses of from ten to fifteen grains, to reduce the temperature.

⁴ As a subcutaneous injection of morphia.

ADENITIS.

(Synonym: *Lymphadenitis*.)

After considering the inflammatory processes connected with the lymphatics themselves, we naturally pass on to a consideration of the inflammatory conditions of the lymphatic glands. Though they may be independently affected, they are, as a fact, most generally involved together with the vessels.

Any irritation may produce a simple adenitis; given a slight contusion of the gland itself, or of a finger or toe, or a pricked finger, not necessarily with a dirty instrument, and inflamed axillary glands may be the result, and, according to the severity of the local inflammation, so will be the pyrexia.¹ In all cases where adenitis occurs, there is a tendency to suppuration. If we examine any gland in which there is threatened suppuration, we may detect either a softening immediately superficial to the gland, or a general softening of the gland itself, indicating the usual condition of central suppuration. The whole reticular structure of the gland becomes choked with pus; and the circulation within it becomes stopped. Hence we may see a mechanical process whereby a gland in such a condition, or one which may have been so affected, may itself become a barrier against the further passage of septic or malignant material. The implication of a series or mass of glands will necessarily induce an œdema of the parts beyond, which may be either transient or permanent. Thus we frequently meet with œdema of the lower limb after adenitis of the glands of the groin, and even if suppuration has not occurred, glands may become permanently enlarged, and their condition, according to the state of the individual's health, induce a form of chronic œdema of the leg or thigh. Such a case has been recently under my observation, where syphilitic bubo, contracted many years previously, left the glands in the groin in this condition, and the parts became liable to chronic enlargement, and the limb to œdema.

Symptoms.—Whether the adenitis be simple or the result of septic material absorbed, the symptoms are much the same, differing only in degree. In the acute stage there are swelling and tenderness, and lancinating pain aggravated by any movement, accompanied by pyrexia, which is more severe, perhaps, in proportion to the nature of the material absorbed, and, as before stated, of the "soil" in which it is absorbed. The cellular tissue external to the affected glands becomes involved, and the integument over it glazed and red. Resolution may occur, but almost invariably suppuration follows these conditions. The abscess bursts, or is opened by the knife, and in most cases a cure is effected; but occasionally the suppuration is chronic, and sinuses form, burrowing amongst neighboring glands and the cellular tissue, excessively difficult to heal, and often showing no tendency to do so. The clinical condition of syphilitic bubo has been already discussed in the article on syphilis (Vol. II. p. 341).

Treatment.—In simple adenitis, the first point is to secure absolute rest, with leeches to the inflamed region, if necessary, warm fomentations or poultices, and, if suppuration occurs, free incision. Some speak highly of the

¹ Lymphadenitis is the most regular attendant on inflammatory processes of all kinds; this is dependent on the "retentive" function of the glands themselves. In the central reticulum of lymph glands, the material portions of the lymph are, as it were, arrested, brought thither by the affected vessels, and may be either innocent or of pathological import. Thus the materials used in tattooing the arm have been observed in the central reticulum of an axillary gland. (Virchow.) Hence it can be readily understood how pus corpuscles or bacteria can be arrested in the gland substance. A stasis naturally occurs, and coagulation of the lymph; and the characteristic hardness dependent thereon commences.

early use of antiseptic lotions. After the complete evacuation of the pus, the wound should be dressed with glycerine and carbolic acid (1-8), and afterwards, when the suppuration has subsided, with iodoform, 1 part, cerat. cetacei, 7 parts; and light pressure with a spica bandage should then bring about a cure (Bradley). Hueter speaks highly of the early injection into the glandular parenchyma of carbolic acid (3 per cent. solution), but I have had no experience of its efficacy. In some cases a peculiar undermining of the integuments occurs, when the burrowing sinuses, with no disposition to heal, must be slit up, and the tracks treated by caustics antiseptically. Scraping away the granulation tissue by means of Volkmann's spoon is frequently of value, and, if large surfaces be exposed, they may be conveniently covered by Reverdin's plan of transplantation of cuticle. The writer has found terebene of great value in this condition after buboes in the groin.

The proper treatment of the caseous infiltration of glands is their total extirpation. In cases of chronically enlarged, painful glands, the injection of a few minims of tincture of iodine by means of a subcutaneous syringe will frequently bring about absorption. Pressure by means of a well-adjusted truss has been tried with good results.

VARICOSE LYMPHATICS.

(Synonyms: *Lymphangeioma*; *Lymphangiectasis*.)

Owing to the difference in the anatomical arrangement of the reticular and tubular lymphatics, there are differences in the dilatations of the trunks and networks. The dilatations of the latter are most frequently observed on the inner aspect of the thigh, the external genitals, and the side of the abdomen. The condition is readily diagnosed; the little boiled-sago-like eminences, which are translucent vesicles, are readily emptied by pressure, and when punctured exude lymph. Dilatations of the superficial trunks are more frequent than those of the réseaux, and differ in appearance, inasmuch as they are, as might be expected, ampullary in shape, and are almost invariably associated with œdema of parts below the tumor. As far as regards the varicose condition of the deeply-seated lymphatic trunks, there can be little doubt that it is the starting point of the lymphangeioma, a comparatively rare condition closely allied to the angeioma, only that the fluid contained within the mesh-work is lymph instead of blood.

Cystic dilatations of the lymphatics are usually found in the tongue (*macroglossa*), in the lips (*macrochilia*), and in the neck (*hydroma*). They have, however, been met with in other parts of the body, such as the axilla and groin.

With regard to macroglossa, there would seem to be a lymphangiectasis, then a lymphangeioma, and then its transition into an angeioma, when the bloodvessels proliferate in the lymph spaces. In macrochilia there is a preponderating development of the lymph vessels. It is a pale, very soft swelling, and can be easily emptied by pressure. The hyperplasia affects the mucous membrane more than the entire lip substance. I have observed, on one or two occasions, a curious blubber-like œdema of the lips following exposure to cold or damp weather, the lips protruding in such a manner as almost to render the individual undistinguishable. This has been in persons of the so-called lymphatic temperament, and has subsided of its own accord. With regard to the cystic hydroma of the neck, Busey states that "Billroth, Lücke, Köster, and others, have classed the congenital cystic hydroma of the neck among the cavernous lymphangiomas. These consist (Weichselbaum) of connective-tissue trabeculae, within whose branches and intercommuni-

eating caverns a serous fluid is contained. This form of congenital cavernous formation occurs most frequently amongst females, has been usually observed in immature children, and is generally complicated with other malformations. The tumor always (Steinwirker) has its principal seat at the lower portion of the occiput and upper part of the neck, is spheroidal, with a smooth surface, and is divided in the median line of the body by a furrow, into symmetrical halves." It is "usually composed of two symmetrical cysts, divided into smaller compartments. The cysts are lined with characteristic lymphatic endothelium, and contain serum. Köster has proved the direct transition of the cysts into ampullary canals and spaces, and has recognized the connection of the latter with the sinuses of lymph glands." These cystic lymphangiomas are not as often the seat of lymphorrhagia as the more common forms. Lymphangiomas have been frequently observed in the groin. The tumor is about as large as the fist, soft to the touch, and when grasped feels like a bag of worms; and it may also be mentioned that this region is liable to lymph-varix and lymphorrhœa.

ELEPHANTIASIS ARABUM.

This disease¹ is essentially lymphatic in its character. Its relation to repeated attacks of erythema is noticeable, and the hyperplasia of the integuments, following a swelling of the lymph glands, ultimately becomes developed into the condition thus named. Virchow classes elephantiasis amongst the fibromata, and describes it as a diffuse new growth, chiefly in the subcutaneous cellular tissue, but sometimes developed in the papillary bodies. New light has recently been thrown on its etiology by the discoveries of Manson, Lewis, and Bancroft, and their investigations show that it is in all probability caused by a hæmatozoon, the *filaria sanguinis hominis*. By its presence in the lymphatics, exudation, œdema, and ultimately organization of the exuded material take place. Sir Joseph Fayrer² gives the following as a general definition of the malady: "Elephantiasis (Arabum) is a non-contagious disease, endemic in certain localities, generally intertropical, and near the seacoast, characterized by recurrence of febrile paroxysms attended by great suffering, inflammation, and progressive hypertrophy of the integuments and areolar tissue, chiefly of the extremities and genital organs, and occasionally by swelling of the lymphatic glands, enlargement and dilatation of the lymphatics, in some cases by the coexistence of chyluria, and the presence in the blood of certain hæmatozoa; the hypertrophy of the integuments resulting in enormous enlargements of the extremities, scrotum, or labia, accompanied by an albuminous deposit in the cells of the areolar tissue, and by degeneration of the muscular and osseous tissues."

This disease must not be confounded with Elephantiasis Græcorum (true leprosy), although, according to Richards and others, they may coexist.

The onset of elephantiasis is frequently violent, and attended with great suffering. There is high fever, intense pain in the lumbar region, groin, spermatic cords and testes, which become much congested and swollen, whilst acute hydroceles form. This is often attended with sympathetic vomiting, nausea, rapid and erythematous swelling of the external parts; and if the extremities be attacked, the swelling is often very tense and painful, accompanied by much effusion into the areolar tissue. The surface of the integument is much inflamed, and sometimes discharges a serous ichor or chyle-like fluid, according to the extent to which the lymphatics are involved in the particular case. There is much constitutional disturbance, increase of temperature, and often depressing

¹ For the statements in regard to elephantiasis, I am largely indebted to the works of those who have had abundant experience in a disease but rarely met with beyond the tropics.

² Trans. Path. Soc. London, 1879.

nausea and vomiting when the cords are implicated; when the great tension and swelling of the cords is apt to dilate the abdominal rings so widely that, when it subsides after recovery, the patient is liable to suffer from hernia through the widened inguinal passages.¹

The general appearance of a portion of the body in an elephantoid condition is that of an enormous hypertrophy of the fibrous elements of the skin, with a copious albuminoid deposit in the cells of the areolar tissue, and great increase in size and prominence of the papillæ. The whole integument is thrown into warty-looking, rugose folds, overhanging or overlapping, precisely like the elephant's integument, and in many positions, as in the scrotum or labia, utterly concealing the true nature of the parts. The term elephantiasis should, according to Fayrer, be limited to the "constitutional form of the disease, that occurs within certain endemic areas, and which is manifested by paroxysmal febrile attacks, accompanied by a disturbed condition of the lymphatic system, chyluria, hæmatozoa, and progressive inflammatory hypertrophy of some portion of the tegumentary system."

As regards *treatment*, no constitutional means have had any beneficial result beyond checking the excess or severity of the febrile paroxysms. It seems that change of climate is a potent remedy in early stages of the disease. As we have to deal more particularly with the surgical aspect of elephantiasis, we may here consider what operative treatment can be brought to bear on such cases.

Removal of the growth not only relieves the patient of the terribly fetid mass, but also relieves him of the accompanying fever, which ceases after the growth is taken away. The most favorable cases for entire removal, which, under these circumstances, gives excellent results, are those of scrotal and labial tumor. The introduction of Esmarch's bandage has rendered the operation bloodless and safe. Before undertaking the removal of a scrotal elephantiasis, the patient should be placed on his back, so as to drain the mass from blood for an hour or so before operating. The neck of the tumor should then be compressed by a modified Esmarch's bandage, and the removal proceeded with. Application of pressure on the abdominal aorta is advisable.

Incisions should be made along the dorsum penis and course of the spermatic cords. The cords, testes, and penis are dissected out, reflected, and held up on the abdomen, while the mass is severed from its perineal attachments. The vessels are tied with scrupulous care, and the wound is dressed with carbolized oil and antiseptic dressing. The wounds heal by cicatrization. Such tumors have been found after removal to weigh as much as 110 pounds.

Ligature of the main artery of a limb, in such cases as elephantiasis of the leg or arm, is useless, and if any good be done it is only temporary. We are largely indebted to the experience of Sir J. Fayrer for what is at present known of the pathology and treatment of this disease, which is rarely met with beyond the tropics, although isolated cases have been observed elsewhere; a detailed account of the microscopical appearance of the tissues involved, in two specimens presented by that surgeon and Dr. D'Arcy Power, will be found in the Transactions of the Pathological Society of London for 1879, pp. 499-503.

LYMPHADENOSIS.

This affection of the lymphatic glands has received various names, and indeed even now the nomenclature of the results of the diathesis thus design-

¹ Fayrer, Trans. Path. Soc. London, 1879, p. 496.

nated, is rather unsettled. Formerly, the affection was termed Hodgkin's disease, progressive glandular hypertrophy, adenia, or pseudo-leukæmia, and the growths were called lymphomata, or vascular sarcomata of the lymphatic glands. We, however, generally adopt the term, "malignant lymphoma," of Billroth, or "lymphosarcoma," of Virchow. Wunderlich appears to have made the first accurate clinical observations on the disease, whilst Virchow assigned to it its pathological position, and Billroth first opened prospects of successful treatment based on his histological researches (Birch-Hirschfeld). We must regard lymphadenosis as a true diathesis, and one marking the lymphatic diathesis in its most "accentuated" form. Primarily a disease of the lymphatic system, it is characterized by the enlargement of groups of glands, or of the entire glandular system. There is always anæmia and absence of tendency to suppuration. It would seem that it is only in isolated cases that the disease is primarily developed in already swollen glands, and in the majority of cases the absence of the scrofulous habit is expressly noticed, the disease making its appearance, as a rule, at a later age than scrofula.

As regards the locality of the affection, we find that the hypertrophy generally commences in the cervical or submaxillary glands, or in the glandulæ concatenatæ. Occasionally the disease commences in the axillary, inguinal, or mediastinal glands, but more frequently these glands enlarge by subsequent invasion. I have now under my observation a man whose cervical glands are so enormously enlarged that it appears as though the face was "peeping" out of the mass, which has been of very rapid growth; the axillary glands are becoming clearly affected. The hypertrophy is generally painless, unless nerve trunks be involved at once, and the glands are very slow to suppurate or degenerate; occasionally, however, they have been known to undergo caseation. At first there is a slow failing of health, in no way marked, but when all the glands are involved the general health begins to suffer; increasing anæmia follows as the disease progresses, the patient, unless some vital part be affected, finally dying from exhaustion. As a rule, the disease proves fatal within two or three years of its first appearance.

When death does not occur under the influence of a local affection of this kind, and extraordinary development, or by the appearance of some grave complication, cachexia of the severest degree ensues. The anæmia becomes so prominent that Wilks named the disease after this symptom *anæmia lymphatica*. . . . In the last period of the disease, insomnia is a frequent symptom (sometimes, on the contrary, somnolence is present), the appetite is completely lost, profuse diarrhœa sets in almost without exception, dropsical symptoms appear, bed-sores form, and finally the patient sinks into collapse.¹

SYMPTOMS OF LYMPHADENOSIS.—With regard to the *symptoms* of lymphadenosis, in the present state of our knowledge we can hardly expect to recognize it until glandular hypertrophy exists, and, of course, when commencing in parts where we cannot palpate, the nature of the disease must remain totally obscure. It is usually quite painless, but is occasionally associated with great pain. In a case under my notice at present, the tumor is growing beneath the upper part of the sterno-cleido-mastoid muscle, and causing intense pain to the patient, who is about twenty-five years of age, and has marked pyrexia. (According to Gowers, pyrexia is present in two-thirds of the cases.) There is no *characteristic* change, however, in the temperature: in the earlier stages there is no fever, but afterwards the evening temperature is higher, and sinks below normal before collapse. Anatomical considera-

¹ Birch-Hirschfeld, Ziemssen's Cyclopædia, vol. xvi. p. 835.

tions, as to pressure or irritation, are, of course, of value in determining the course and character of this disease.

Progressive anæmia is always associated with the hypertrophy of the glands, wherever situate, accompanied with sweating, nervous depression, and often syncope. As regards the condition of the blood, there is, perhaps, no increase in the white corpuscles, though the red are much diminished, and it is so much paler in appearance than normal blood, that Gowers has compared it to "diluted claret." We invariably observe mental depression or hysteria in these cases.

DIAGNOSIS.—The *diagnosis* of lymphadenosis is not always easy. We have to differentiate it from cancer, scrofula, and leucocythæmia, and in the outset of the disease the diagnosis is probably impossible. In lymphadenitis, as before stated, on examining the blood, we find that the red corpuscles are diminished in number, while the number of the white corpuscles is unchanged, although we may have *leucocythæmia* coexistent, as instanced by general lymphatic enlargement and an increased number of white corpuscles.

In the diagnosis from *struma* or *scrofula*, which again may be coexistent, we may be guided by the marked absence of the tendency to periadenitis, suppuration, or degeneration and softening, which we always meet with in enlarged strumous glands. These glands in struma, rarely, if ever, attain the enormous size they do in lymphadenitis, and are slower in growth; moreover, a few only of a group of glands are affected, whereas in lymphadenosis the gland invasion is general, and there is an absence of the nodular, hard, banded masses so noticeable in struma.

In its differentiation from *cancer*, which is rarely a primary glandular affection, we notice that lymphadenosis is invariably so; we also observe its early development, the freedom of movement of the superficial integument, and the presence of splenic or thyroid mischief; and on microscopic examination we find that the cell growth is lymphoid in lymphadenosis, and epithelial in carcinoma.

The diagnosis between *sarcoma* proper and malignant lymphoma is of importance, since in the latter extirpation of the gland holds out no chance of success, whereas a timely removal of a sarcomatous gland may do so. The essential difference, according to Winiwarter, "seems to be the fact that lymphoma consists of a hyperplastic process, while such tumors only are to be regarded as sarcomatous, as in type have nothing in common with the mother tissue." Sarcoma extends directly to neighboring tissues, and is liable to retrograde metamorphosis and ulceration.

Anatomically, we may distinguish two forms of malignant lymphoma, the *hard* and the *soft*, but, as originally suggested by Virchow, there does not appear to be any *clinical* difference between them. The distinction, indeed, according to Langhaus, is not accurately definitive, for we may meet with a mixed form in the same individual. In the soft form, as far as it interests the surgeon, the several glands forming the group can be readily made out; the integuments, as a rule, are non-adherent, and glide freely over the mass, and it is very rare to find the growth invading neighboring tissues. With regard to the microscopic appearances of these two forms, it would seem that "there is no essential contrast between them; in the *soft* form the cell formation is more abundant, and the new formation preserves mainly the embryonic character, while in the *hard* form the new growth undergoes a species of fibrous metamorphosis." (Birch-Hirschfeld.)

Wilks places lymphadenosis clinically between tubercle and cancer, and Gowers says, that "in order to explain the phenomena of Hodgkin's disease,

it is necessary to assume the existence of a general dyscrasia affecting the lymphatic tissues, of different intensity and different operation in different cases, but existing in all."

PROGNOSIS.—As to the *prognosis* of this disease, we must at present regard it as exceedingly unfavorable, almost equally so with cancer. According to Bradley,¹ there would seem, however, to be a tendency to exaggerate the gravity of the malady in its earlier phases. "If the spleen be not implicated, if only certain groups of glands be affected, *e.g.*, the cervical, axillary, and inguinal, and if the temperature be normal and steady, a fairly hopeful prognosis may be given. . . . If, on the contrary, the spleen be much enlarged, if there be leucocythæmia, if the thoracic and abdominal glands participate in the disease, or, and this is a point to be especially attended to, if the temperature be high and irregular, the prognosis is exceedingly bad, indeed, may be said to be uniformly fatal." Therapeutics, however, latterly seem to have afforded some good results.

TREATMENT.—As regards surgical treatment, it is usually hopeless, and even in the earlier stages it is but of little avail. All local sources of irritation should be removed, and careful attention should be paid to the hygienic condition of the patient, while as remedies, cod-liver oil, iodine, and phosphorus may be administered. Arsenic appears to have been of great value in the form of Fowler's solution, and is highly spoken of by Winwarter, Czerny, and Billroth. Cold, injections, counter-irritants, caustics, pressure, massage, écrasement, and electricity, would seem to be invariably useless, and often dangerous.

If removal be decided on, and I confess the chances it incurs are about on a par with those of the attempted removal of any malignancy,² the incision, or incisions, to expose the growth must be carefully planned. The operation may be very easy or very difficult, but if the capsules of the glands are not adherent or softened, the removal is practicable. We must cut down on the tumor, giving free room for the use of the fingers, and indeed, after the primary incision, we must depend upon "tearing," or enucleation; bleeding vessels must be tied as we proceed, and the operation resolves itself into a process of "digging." I removed an enormous mass of these glands (cervical) some time since in the Charing Cross Hospital, and it seemed that the more we took away the more there was to remove. There was but little hemorrhage, and the patient for a while did well, but the return was as speedy as if the mass had been medullary. As far as the utility of removal goes, excision would seem to be merely practice in operative surgery, and an exhibition of manipulative skill, and sometimes of daring. Unless the disease is attacked very early, an operation is quite useless.

CONDITION OF THE LYMPHATICS IN SYPHILIS.³

The introduction of the syphilitic virus into the system takes place either by abrasion, by puncture, or by absorption through the mucous membranes or cuticle, without the presence of any actual lesion.

¹ Op. cit., p. 119.

² But, as Billroth says, destruction or extirpation of the glands is "still more worthy of recommendation, if the modern views as to the origin of tuberculosis should prove true, viz., that every caseous area, especially if it exist in a lymphatic gland, may prove to be a source of danger." (Billroth, Clinical Surgery, p. 151. London, 1881.)

³ This subject is more fully discussed in the article on Syphilis.

In all probability the syphilitic virus is a *contagium vivum*, and although it has not as yet been definitely determined microscopically whether the bodies seen are germs (micrococci), it would seem, from the manner in which the virus travels in experimental inoculations, that they are so.¹ The chain of events after inoculation, seems, in general, macroscopically, to be very analogous to that occurring after any inoculation with septic matter, but the *action* of the poison is specific. After the appearance of the chancre or initial lesion, we find the entire lymphatic system "showing up," as it were, the invasion of this peculiar virus. There is a period of latency, the cell proliferation is slow and slight perhaps, but the general infection is entirely due to the lymphatic system.

Some time after the inoculation, the period varying greatly, the course by which the poison reaches the neighboring glands may be shown by a cord-like thickening of the ducts. This is distinctly observable on the dorsum penis, or, in the case of the mouth, in ducts leading to the buccal and labial glands; in the case of the mammae, in those leading to the superficial axillary glands. With regard to the changes taking place, Von Biesiadecki² "found the muscular fibres in such lymphatic vessels enlarged, through the presence of numerous exudation cells; the adventitia was contracted, containing only a few of these cells; the vessel was in places plugged by a coagulum, or closed by a thickening and folding of the intima. The immediate vicinity of the lymphatic vessel was but little changed; rarely a few exudation cells appeared between the fat cells." Neighboring glands become slowly affected, a condition never observable before the primary affection, but usually from the eighth to the eleventh day; in a case observed by myself, of a student inoculated from a midwifery case, the supra-condyloid gland was enlarged in seven days, and the axillary glands in fourteen. Bäumler, quoting Rindfleisch,³ observes that *histologically* these glandular swellings represent a *hyperplasia of the cellular gland elements*, and the chronic induration of the glands is due, not so much to a hardening and enlargement of the reticulum, as to a very uniform, though by no means exuberant, growth of young cells in all portions of the gland. The involution is effected through fatty metamorphosis and absorption. Under certain circumstances caseous and calcareous degeneration may take place. In course of time the poison reaches the thoracic duct, and is poured into the bloodvessels, to be speedily followed by a specific fever, with a characteristic eruption.

Those structures of the entire system which are essentially lymphoid evince the peculiarities of their invasion. The tonsils enlarge and ulcerate. The posterior cervical glands enlarge, and in many instances the condyloid glands of the elbow; and in the cellular tissue of the viscera, which is largely composed of lymphatics, we find the later and more important lesions of syphilis. A portion of the poison circulating in the blood gives rise to the cutaneous *syphilides*—an effort at elimination; a greater part still continues to travel along the lymphatics, and gives rise to the characteristic glandular and visceral lesions elsewhere described. In the tertiary form of the disease we find no hardening or thickening of the glands, but what has been termed by Collin a "catarrhal" affection.

CANCER OF THE LYMPHATICS.

As the whole subject of cancer will be dealt with in the article on Tumors, it is proposed to do little more than allude to the condition in the present place.

¹ Some researches by the author, now going on, are not ready for publication.

² Ziemssen, op. cit., vol. iii. p. 117. Quoted by Bäumler.

³ Ziemssen, op. cit., vol. iii. p. 120.

Although the materies morbi of cancer is well known to traverse the lymphatics, yet primary carcinoma is very rarely, if ever, met with in the lymphatic glands. Billroth is decidedly of opinion that primary carcinomatous affections of the lymphatic glands are of very rare occurrence; but as they are the parts which give passage to the fluids of the tissues as they pass on their centripetal course, a strict separation would only be possible where heteroplastic new formations were found in the lymphatic glands;¹ and Paget states that, as a primary disease, scirrhus cancer of the lymphatic glands is very rare, the cancer which most frequently appears first in them being the medullary.²

There would appear to be but little doubt that the *epitheliomatous* form of carcinoma is invariably of epithelial origin, the epithelial cells being most like the parent cells of the cancer cells, and it is readily seen how epithelial elements would select the lymph-channels for their passage, owing to their intimate association with the mucous membranes and skin and cellular tissue. The actual passage of cancer cells along the ducts has not been often observed, but when the glands have become infected, the afferent vessels have always been found loaded with cancer cells; and it is more than probable that the cancer juice, or altered cells, is sufficient to induce infection, since we find that the secondary growths are precisely similar to the primary.

A study of carcinomatous tumors of the breast, from their frequency and position, affords a field of research on the peculiarity of the invasion of this neoplasm. The views of Creighton³ seem to point out that the secondary infection of the glands is caused by pigment cells, which either act upon the lymphoid cells, or undergo rapid self-multiplication. This would seem to be borne out by the experiment of engrafting the cuticle of the negro into a granulating sore on a white man, when it was found that the pigmented character of the cell was communicated to all the newly-formed cicatricial cells of which the dark cells were the parents.⁴

Dr. Hoggan's views⁵ with regard to the mode of infecting lymph glands with cancer may be briefly stated as follows:—

Using the word cancer in the general sense (scirrhus), amongst the most important of these conclusions are the following:—

“As soon as the lymphatic glands become affected, all the lymphatic vessels between them and the morbid part become filled with a plug formed of cancer cells. . . .

“Contrary to expectation, the lymphatic vessels on the distal side of the tumors become also filled up with a plug of cancer cells. This is due, apparently, to the impaction and accumulation of lymph or wandering cells coming down with the lymph stream against the distal ends of the cancerous plugs in the already occluded lymphatics, and there they themselves become cancer cells by contiguous infection. . . .

“By prolonged exposure to the contagion of the plug of cancer cells within the lymphatics, the endothelial cells, which form their sole wall, become cancerous, and their nuclei begin to swell and become more pellucid, while, although the cells retain their shape and position, they seem to change their nature.” . . . “The one thing needful for the development of secondary cancers from the lymphatics is the presence of groups of wandering cells in close proximity to cancerous lymphatic walls.” . . . “When a lymphatic or wandering cell becomes infected, it gradually increases in size in all its elements, and if originally irregular in form becomes egg-shaped. The cell substance proper (protoplasm?) becomes more pellucid and refuses to stain with colors, appearing to become vacuolar, which, however, it does not, but rather reminds one of the external swelling undergone by a pellet of hard gelatine when it is first steeped in water.

¹ Billroth, op. cit., p. 162.

² Paget, Lectures on Surgical Pathology, p. 609. 1863.

³ On the Physiology and Pathology of the Breast.

⁴ Bryant, Manual of the Practice of Surgery, 2d edition, vol. i. p. 163.

⁵ Transactions of the Pathological Society of London, 1878.

This swelling goes on until the cell has reached a comparatively enormous size, when the substance proper seems to melt away as a fluid, thus freeing its nucleus (or nuclei), which now becomes the actual cancer cell. . . . The nucleus of the wandering (or lymph) cell, now itself become the cancer cell, may increase in size to above 200 times the size of the original cell."

Gussenbauer, in an elaborate paper on the development of secondary tumors of the lymphatic glands,¹ is much of the opinion of Creighton and Hoggan, though modified. Histologically, his observations are evidently in favor of the theory that the tissues of the lymphatic glands are transformed, by infection, into a structure resembling that of the primary tumor. He mainly agrees with Hoggan, that the linear cords of new growths are not due to plugging of the lymphatic vessels by cells detached from the primary tumor, but to proliferation and transformation of the epithelium all along the lymphatic vessels by continuous extension of infection. He does not find that the *afferent* vessels or the peripheral lymph sinuses are occupied with transported cells or beginnings of new growths; but in the follicular tissue he describes a kind of corpuscular element, fertilizing germs (*befruchtende Keime*). They are carried by the lymphatics from the primary tumor, and infect constituent elements of the gland in such a way that they become transformed into the likeness of cancer cells. This is more particularly observed in the case of melanosis.

As a complex transformation of lymphatic gland forms, in the case of primary colloid of the rectum, Gussenbauer describes the change into spaces lined with epithelial cells containing colloid material. The epithelially-lined spaces are traced back through several stages, and ultimately identified as blood-vascular channels, whose epithelial, muscular, and other elements have taken on active proliferation, and ultimately the distinctive form and arrangement of the cells lining a glandular tube.

Particular attention is called to the fact of the participation of the various coats of the bloodvessels in the formation of the secondary new growths.

Clinically, as to the detection of non-infiltrated, infiltrating, or infiltrated glands, there is obviously great difficulty in the early stages of the disease. We know well that in the normal condition, glands vary much in size in the quite healthy individual, and the advice of the surgeon, in cases of cancer, is rarely sought until the affection has made headway. If we take, for instance, the breast, whence most of the clinical investigations have been made, we find that almost invariably, at the time of examination, the glands are involved—an aid to diagnosis, truly, but greatly against our success in operation. The great clinical question to be answered is, "When do the glands become affected?" and any statements as to the rate of infection would be of the greatest clinical value. Any enlarged lymphatic gland in the neighborhood of a cancer must be regarded with suspicion, and treated accordingly; hence the necessity of emptying the axilla of its glands in excisions of the breast.

To briefly summarize what has been said, we may, from what we know at present, assert that, as far as the infection of the lymphatic system is concerned, syphilis is a virus, possibly a "contagium vivum," invading the lymphatics; and that cancer is a dyscrasia (perhaps hereditary), which by means of the connective tissue involves a part or parts of the entire system. The term *epitheliosis*, as suggested by Bradley, seems to be a generalization of convenience. The question of visceral cancer and its relation to the lymphatic system will be found treated of elsewhere; those points which are of special interest to the surgeon have been alluded to in the present article.

¹ Zeitschrift f. Heilkunde, März, 1881. Ueber die Entwicklung d. sec. Lymphdrüsesgeschwulste.

BIBLIOGRAPHY.—The more recent accounts of the relation of cancer with the lymph system will be found in papers by Waldeyer, *Die Entwicklung d. Carcinome*, Virchow's Archiv, Bd. xli. S. 470; Gussenbauer, *Ein Beitrag z. Lehre v. der Verbreitung des epith. Krebs auf Lymphdrüsen*, Arch. für klin. Chir., 1872; Id., *Ueber d. Entwick. d. second. Lymphdrüsengeschwülste*, Zeitschrift. f. Heilkunde, März, 1881; Billroth, *Lectures on Clinical Surgery*, 1882; Curnow, *Gulstonian Lectures*, 1880; Rindfleisch, *Lehrb. d. path. Gewebelehre*, 1875; A. v. Winiwater, *Die allgemeine chirurgische Pathol. und Therap.*, 1880; Chambord, *Du Carcinome primitive des Ganglions Lymphatiques*; Kocher, *Primäres Achseldrusencarcinom. nach chronische Mastitis*; Creighton, *Pathology and Diseases of Breast*, 1879; Hoggan, *Transactions of the Pathological Society of London*, 1878, and *Archives de Phys. Norm. et Pathologique*, 1880.

SURGICAL DISEASES OF THE SKIN AND ITS APPENDAGES.¹

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AFFECTIONS OF THE SEBACEOUS GLANDS.

COMEDO. (Synonyms: *Acne punctata*; *Grub*.)—When the secretion of the sebaceous glands is prevented from escaping, that portion which is exposed at the open mouth of the follicle becomes discolored by contact with external foreign matter, and forms a conspicuous dark speck resembling a grain of gunpowder embedded in the skin. By the continued accumulation of sebum within, the gland may become markedly prominent above the surface of the skin, and may attain the size of a mustard-seed or small shot; or by its distension may provoke an inflammation of the surrounding cutaneous tissues, and thus be converted into a true acne pimple. If pressed upon, the contents may be squeezed out in the form of a cylinder of white cheesy matter, which, with the blackened tip, resembles a maggot, whence the popular name, “worm,” or “grub.” Examined by the microscope, this material is seen to be composed of fatty and modified epithelial cells, cholesterine, and lanugo hairs, which have been prevented from issuing from the adjacent hair follicle by this hardened sebum plug within their common duct. Occasionally, too, one or more of the microscopic parasites (*demodex*) of these follicles are thus removed, although their presence is in no way connected with the formation of the comedo.

Comedones occur principally upon the skin of the forehead, nose, and temples, but may affect any portion of the body. Like other disturbances of the sebaceous glands, they appear most commonly at the age of puberty, but, if not removed artificially, may last for an indefinite period. They are apparently in no way connected with the general condition of the system, but are often associated with juvenile acne. The cause of their formation is not clearly understood. It may be an alteration in the normal character of the sebaceous secretion, an undue proliferation in the cells which line the exit duct, or a want of tone, or sluggishness, in the gland.

Treatment.—The surgical treatment of comedones consists in the forcible evacuation of their contents. This can generally be accomplished by the opposing pressure of the two thumb nails, but better by direct perpendicular pressure with a watch key. One with a small aperture and broad edge should be employed, so that the surrounding skin may not be too violently bruised. The operation should not be performed upon several contiguous glands at

¹ The nomenclature and classification followed in the ensuing article are those adopted by the American Dermatological Association.

once, lest inflammation be excited in them. The following method may be observed with advantage: Let the affected parts be bathed or sponged with quite warm water for five minutes, and then rubbed with olive oil. In a few minutes more, the key may be applied with sufficient force to press out the now softened contents of the glands. This process should be repeated daily until all the comedones have been removed, and subsequently, as often as they continue to re-form. Much may be done to correct the sluggish action of the glands by the frequent use of strong soaps, in connection with liberal oiling of the skin beforehand. The best preparations are the liquid glycerine soap made in Vienna, or a solution of German soap (*sapo viridis*), or well made domestic soft soap, in alcohol, to which after filtration glycerine has been added. (R. *Saponis mollis* 3j, *alcohol* f3ij, *glycerinæ* f3ss. M.) These should be rubbed into the previously oiled skin with a bit of sponge. The same sponge dipped in water should then be rubbed upon the part until a thorough lather is established, when water should be applied for a considerable time by the hands or a large sponge, until the soap is entirely washed off. Any overaction of the soap may then be corrected by the application of a little more oil, olive or almond, or of cold cream ointment or vaseline. The whole process is best carried out just before going to bed.

MILIUM. (Synonyms: *Grutum*; *Strophulus albidus*.)—This is another affection of the sebaceous glands, caused by retention of their secretion, in the form of pearly or yellowish-white, firm, little, globular bodies embedded in the skin and projecting slightly above its surface. These vary in size from that of a mustard-seed to that of a small pea. They lie just beneath the epidermis, and have no opening upon the surface. Their seat is most commonly the skin of the face, especially about the eyelids, and the male and female genitals. They are the result of an accumulation of sebaceous matter in one or more lobes of superficial glands, arising from occlusion of the sebaceous duct before its entrance into the common canal, as is shown by their occurrence along the edges of cicatrices, and after severe dermatitis; more generally, however, probably without mechanical obstruction, in consequence of changes in the character of the secretion. The contents of these little cysts are found to consist of hardened epithelial cells, arranged in concentric layers at the periphery of the globular mass, and, in the central portions, of firm but more fatty sebaceous cells. Colloid degeneration of the epidermal contents has once been observed. When occurring in great numbers, as they sometimes do, upon a darkly pigmented skin, they become a serious deformity.

Treatment.—Milia may be removed easily by cutting through the thin overlying epidermis, and squeezing out their contents with the nail or the edge of the knife. A slight degree of bleeding sometimes follows, which is readily checked by pressure.

SEBACEOUS CYSTS. (Synonyms: *Atheromata*; *Wens*.)—These tumors, situated within and beneath the skin, consist of hypertrophied sebaceous glands filled with their retained and more or less modified secretion. They vary in size, generally from that of a pea to that of a pigeon's egg, but are sometimes larger. They may occur on all parts of the body, but their most common seat is the scalp, and they may occur singly or in considerable numbers. The orifice of the affected gland is generally obliterated, but sometimes remains open, and may be so much enlarged as to admit a probe. The tumors are soft, or firm and elastic to the touch, are movable, and vary in shape according to their age and the resistance of the overlying skin, being flattened, or prominent and globular. The integument above them almost always remains in its

natural condition, but the scalp becomes denuded of hair when they attain any considerable prominence upon it, and may assume the condition of senile atrophy above them. Their growth is very slow, and they may exist for years, or a lifetime, without producing other inconvenience than that which arises from their size alone. When the cyst is removed by dissection from its enveloping tissues, its walls are found to be soft, thin, and fragile, when of recent formation, but much thickened when old, and sometimes permeated by calcareous deposits. The internal surface of the cyst is smooth, but has sometimes a villous appearance. The contents vary greatly in consistence and color. In the early stage, they are generally the retained sebaceous matters, resembling curds. At a later period they become, in character, more like epithelium in various states of transformation, mixed with fat and cholesterine (*Cholesteatoma*). Sometimes they undergo nearly complete liquefaction, or are honey-like in appearance (*melicerous*). Fine hairs are occasionally found in them, and calcareous matter. Rarely a horny epithelial growth starts up within the cyst, and may eventually be converted into a *Cornu cutaneum*. The contents are never hemorrhagic, as the walls are not vascular. The sebaceous cyst is liable to inflammation at times, without apparent cause. It may be converted rapidly into an abscess-like mass of suppuration, confined within its walls; or the overlying integument may become purple, soften, and undergo perforation, and a fistula may thus be formed, through which extremely fetid pus may be discharged for a long time, in which case the underlying cranial bone may be found carious, or the protecting skin may slough extensively, leaving a mass of ulceration which may extend to the surrounding tissues and present a very malignant appearance. Although ordinarily of easy recognition, the sebaceous tumor in its later stages, especially when of considerable size, or when its walls have become thickened, may be confounded with more serious growths, as hæmatoma or carcinoma.

Treatment.—Sebaceous cysts may be removed by excision, or destroyed by caustics. Under ordinary conditions, or when of any considerable size, extirpation by the knife is the proper method of treatment. The overlying skin should be put on the stretch and cut carefully through to the cyst wall, over the whole length of the tumor. By careful dissection, the cyst may then generally be removed entire. Should the walls be cut or ruptured accidentally, the contents should be evacuated by pressure, and every portion of the envelope dissected out with great care. The wound generally unites by first intention. [In excising sebaceous cysts from the region of the scalp, it is more convenient to transfix the base of the tumor with a slender bistoury, and then bisect the growth by cutting directly upwards. Unless it has been inflamed or ulcerated, the cyst wall is very loosely attached in this situation, and can usually be pulled out with forceps without the trouble of dissection.]

The danger of erysipelas attendant upon all operations upon the scalp must, of course, be borne in mind when this is the seat of the tumor. It is on this account that some surgeons prefer to employ caustics upon this region, when the cyst does not exceed a pigeon's egg in size. For this mode of treatment, caustic potassa, Vienna paste, or nitrate of silver, may be used. When the cyst is quite small, a pointed stick of nitrate of silver may be moistened and made to revolve gently upon its tip on the skin above the tumor, until it penetrates its tissues slightly. A small eschar is thus produced, which falls in a few days. The operation is then repeated, and the stick is made to enter the cyst, and to come in contact with the walls. The envelope may then be removed with fine forceps, after emptying the contents by pressure, and the cavity, in three or four days, closes by adhesion of its walls, and leaves an imperceptible cicatrix. Upon larger tumors, the Vienna paste may

be used in the following manner.¹ The surface is covered with diachylon plaster, from which a button-hole has been cut out, of the length of the tumor, and of one-quarter its width. A coating of the paste, diluted with alcohol, is then laid upon this opening. After fifteen or twenty minutes, the paste is carefully and wholly removed. In two or three weeks the eschar is detached, bringing with it the shrivelled and mummified cyst. After a few days, the large and deep opening cicatrizes, and leaves behind only a small linear scar.

MOLLUSCUM CONTAGIOSUM. (Synonyms: *Molluscum sebaceum* ; *Epithelioma molluscum* (Virchow); *Condyloma subcutaneum*.)—Under these titles, there have been described by different writers, small tumors of the skin, the identity and true nature of which have long been the subject of controversy. They are semi-globular, conical, or flattened prominences, of the same color as the skin, sometimes shining and transparent, sometimes warty in appearance. In size they vary from that of a pin's head to that of a large pea. They generally present a minute opening at the tip, or, when large, an umbilical depression, which gives them a resemblance to the efflorescence of varicella. Their seat is most commonly the face, neck, or genitals, but they may appear upon nearly all parts of the body, and in numbers varying from one or a few, to a hundred or even more. Their growth is generally slow, and their course chronic; they may at times disappear spontaneously. Their presence is unaccompanied by any disturbance of sensation of the part, except when they are accidentally the seat of inflammation, by which they may be destroyed. They are observed more frequently in children than in adults. If one of the growths with a visible opening be firmly squeezed between the thumb nails, its contents may be pressed out in the form of a fluid, creamy material, which consists of epithelial cells, fat globules and crystals, and certain larger, irregular, ovoid, shining bodies, some of which are enveloped in a thin epidermal covering. These peculiar bodies have been called *molluscum corpuscles*, and are regarded as epithelial cells, the protoplasm of which is in a state of amyloid degeneration. They are not peculiar, however, to these growths. If one of the tumors be examined in section, its structure will be seen to be multilobular, like the sebaceous glands, and to contain a central cavity. The peripheral cells resemble those of the rete, and are arranged like them in superimposed layers. It is on this account that several authors regard these growths as belonging to the rete and not to the sebaceous system, among the affections of which they are usually classed. It is in the central portion that the peculiar large cells are found. Clinically, Kaposi divides them into the encysted form (*Molluscum atheromatousum*), and the wart-like variety (*Molluscum verrucosum*).

As to the property of contagiousness, implied in the specific title bestowed upon this affection by Bateman, observers are still at variance, and the question may still be regarded as an open one. Those who support the theory of contagion, offer numerous facts concerning which there is no doubt: that the disease has been frequently observed at the same time upon the face of an infant and the breast of its nurse; that it has affected several members of a family in succession; that the entrance of a child, thus affected, into a hospital or foundling asylum, has been followed by the appearance of these growths upon its nearest fellows, etc. On the other hand, there are no perfectly satisfactory successful experiments by inoculation, to support this view, although negative results in this direction are of little positive weight, because the requisite conditions for successful transference of the possibly inoculable matter

¹ Misset, Étude sur la pathologie des glandes sébacées, 1872.

may not have been observed. Experiments failed for many years to establish *Tinea favosa* upon the skin of a second host, although it was known that the disease was contagious, and that the material used was parasitic.

Treatment.—The treatment of these growths consists in evacuating their contents by forcible pressure with the thumb-nails, when they are pervious, and in arresting the free hemorrhage which follows by pressure. When in the form of closed cysts, they may be scooped out with the sharp spoon (curette), or removed by the knife or curved scissors. When very numerous and closely packed together, exfoliation of the overlying integument and discharge of their contents may be accomplished by covering them with compresses thickly spread with German or domestic soft soap. The application of solid nitrate of silver or caustic potassa to the interior of the cysts, after squeezing out their contents, has been advised, but is seldom necessary.

INFLAMMATIONS OF THE SKIN.

DERMATITIS VENENATA.—Many substances when brought in contact with the skin are capable of exciting an inflammation of its tissues. The forms of dermatitis of this character, most frequently observed, are those produced by the poisonous species of *Rhus* (sumach), by tincture of arnica, and by certain dyes. The frequent occurrence of cases of poisoning by the plants mentioned, makes it the duty of physicians to acquaint themselves with their botanical characters.

Poison ivy, as it is popularly called, is not an ivy, but belongs to the sumachs. It is the *Rhus toxicodendron*. It is sometimes a vine (*Rhus radicans*) running over or by the side of stone walls, fences, and ledges, or ascending trees to a great height, and sometimes a bush of considerable size and thickness (poison oak). It is found almost everywhere in the United States, in many places growing in great abundance, and forming dense masses by roadsides, in pastures, and along the borders of woods. Its leaves have a marked and very characteristic, glossy look, and vary greatly in shape, size, and outline. They are ternate, that is, they consist of three leaflets, one terminal and two lateral, growing in common upon a rather long, semi-cylindrical stem. The leaflets are ovate, with rather a broad base, more or less pointed, and their edges are either entire, or notched and lobed in a great variety of forms. This plant blossoms in June, and the flowers are small, and grow in greenish-white clusters, mostly on the axils. The berries are small, round, and also of a pale greenish-white color. Later in the season, the leaves assume a great variety of most brilliant colors, and attract many gatherers of autumn foliage. At this season it may readily be mistaken for our common woodbine or Virginia creeper (*Ampelopsis quinquefolia*), unless it be remembered that the number of leaflets in the latter is five.

The other poisonous species of *Rhus*, *Rhus venenata*, a small tree, growing mostly in swamps and low places, is much more virulent than the former, but is not so common. Its popular names are "poison dogwood," "poison sumach," "poison ash," etc. Its leaflets, like those of the ordinary sumach, grow in opposite pairs upon a long stem, and vary in number from seven to thirteen. They are smooth, glossy, broader than the harmless species of sumach, and the terminal one grows from a considerable prolongation of the common stem. In the autumn its foliage surpasses that of all other trees in the variety and brilliancy of its tints, and thus attracts to its less frequented haunts not a few unwary visitors.

The virulent principle of these plants is a volatile acid, which exists in all their parts, but especially in the leaves. All persons are not affected by it,

but many who can handle the vine, *Rhus toxicodendron*, with impunity, are poisoned by the tree, *Rhus venenata*, so much more virulent is the latter. Actual contact with the plants is not in all cases necessary for the production of their poisonous effects, on account of the volatility of their active principle; and there is good reason to believe that persons highly sensitive to the poison not unfrequently suffer on passing by places where the vine grows abundantly. The plant is supposed to be most actively virulent during the flowering season, in early summer, but cases of poisoning occur with great frequency throughout the autumn, when the leaves take on their seductive coloring. Even in the winter, the twigs and stems are often found still alive for mischief by those who handle them.

The peculiar effect of the poison is of the same character upon the skin of all who are affected by it, differing only in degree of intensity and extent of distribution, viz., an inflammation of the eczematous type. It is characterized by an eruption of vesicles, at times of a peculiar lurid or brownish-red color; which may subsequently burst and exhibit the later phases of this efflorescence, as in other forms of dermatitis. In severe cases we have multiplication of the number of vesicles, either single or massed in groups, covering large surfaces, or by fusion forming blebs. In addition, there are more or less redness and œdema of the surrounding integument, sometimes to a very marked degree, so that great deformity may thus be produced, the face of the patient being changed out of all possibility of recognition. These changes in the tissue of the skin are accompanied by intense itching and burning, and often great suffering is undergone by the patient in consequence. There is rarely, however, any constitutional disturbance. If then the cutaneous manifestations are those of acute eczema, have they no individuality by which they may be distinguished? There are differences to be recognized by the practised eye, but they are more easily detected than described. The eruption appears most easily, therefore generally first, upon the lateral surfaces of the fingers, or along their edges; at a later period, upon the dorsal surfaces; and last, upon the thickened palms. It is more scattered and more irregular in its distribution than that of ordinary eczema. The character of the efflorescence, too, is strikingly peculiar, although indescribable. It is more uniformly vesicular than vesicular eczema. The vesicles appear less transparent, as if the effusion of serum had taken place in the lowest layers of the rete, and they have at times a peculiar tinge of color, as if slightly hemorrhagic from the intensity of the inflammation. Upon the palmar surface, the epidermal coverings of the vesicles are so dense that they look and feel more like papules. In its later stages, those of involution, the skin returns to its natural state without any marked change in the character of the efflorescence.

In mild cases, the inflammatory process is seldom carried so far as to transform the vesicle into a pustule, and, after reaching its height, its serous contents are slowly absorbed, and it flattens down, leaving a fugitive, dull-colored stain to mark its seat. In the severer forms, the œdema and hyperemia rapidly subside under treatment, and the excoriations, crusts, and infiltration, disappear in the same manner as in acute eczema. The eruption generally shows itself within three or four days after contact, sometimes within twenty-four hours, and the duration of the attack depends largely upon the protraction of the period during which fresh efflorescences manifest themselves. This generally lasts from ten to fourteen days from the appearance of the first eruption. Even in the severest cases, where the changes of tissue reach their highest possible development, and affect large surfaces of the body, the duration of the whole process of evolution and involution rarely exceeds three or four weeks. No scars or permanent injury to the skin are to be apprehended.

There is no ground for the popular belief that the poison renews its activity

after the lapse of time, although there is good reason for believing that the skin is more liable in some persons to inflammatory disturbances, for some years it may be, after an attack of rhus poisoning. Acne and acute eczema are the secondary affections most commonly observed as its sequelæ. Susceptibility to the action of the poison seems never to diminish in the same individual, however often affected by it.

The question is often asked by patients: Is ivy-poisoning contagious? will contact with the eruption, or the fluid discharge, produce the disease upon other parts of the same person, or upon the skin of another individual? It is not at all improbable, that a person who had been handling specimens of rhus, might, by immediately taking the hand of another, excessively sensitive to its action, and before the volatile principle had been dissipated, washed away, or absorbed, convey the poison, which would subsequently prove effective. It is, no doubt, in this way that the face, penis, and other parts of the body become affected, where the hands only have come in direct contact with the plants; but the freest handling of parts affected, in all stages of the efflorescence, fails to transfer the disease to the hands of another.

Treatment.—The poison, as has been stated, is a volatile acid. An alkali would, therefore, suggest itself as the most fit agent to counteract its action. Thorough washing of the parts, as soon as possible after contact with the poison, in cooking soda or saleratus water, or in strong soapsuds (especially if made with soft soap, which contains an excess of alkali), is therefore the best immediate treatment. When these or other alkaline preparations are not to be obtained, an abundance of water alone should be used as soon as possible. After absorption has taken place, or when the eruption has begun to show itself, less benefit is to be expected from such applications alone. Remedies are then to be used which will best control and shorten the inflammatory process in the tissues of the skin: those, in fact, which are found to be most efficacious in corresponding stages of acute eczema. Among these are some which have a special reputation, as solutions of acetate of lead or sulphate of copper, applied frequently as a wash. A large number of vegetable substances have been recommended as exerting a specific action upon the course of the disease, when locally applied. Among them are white-oak bark, black alder, *grindelia robusta*, and *serpentaria*. Bromine has lately been added to this list. Perhaps nothing is better than black wash (calomel ʒj, lime-water Oj), used as an evaporating lotion for half an hour at a time, twice daily—the lime-water acting also as a chemical antidote, if, possibly, such action be still in season at this later stage. In the intervals between the applications of these washes, the parts may be kept covered with cold water dressings, with plasters of diachylon ointment, or with a powder of starch ʒj, oxide of zinc ʒj, according to the familiar rules for the treatment of acute eczema. By such means the inflammatory process is checked or shortened, and the sufferings of the patient are greatly alleviated.

ARNICA POISONING.—The *tincture of arnica* is another frequent source of “poisoning,” when applied to the external surface as a popular remedy in sprains and bruises. It causes, upon some persons, an intense dermatitis of an eczematous type, but necessarily upon a small proportion only of those who use it, inasmuch as it is employed in enormous quantity for the purpose named. The cutaneous manifestations consist in the development of hyperæmia, papules, vesicles, excoriations, crusts, and scales, in regular sequence, accompanied by intense itching and some degree of burning in the parts affected, but by no constitutional disturbance. The inflammation begins in the parts to which the arnica has been applied, after intervals varying from a few hours to several days, but may spread from such centres to

wider areas, in consequence of scratching, or may be developed upon distant regions which have come in indirect contact with the arnica by the agency of the hands. The affection follows a very regular course in the character, distribution, and duration of its lesions, differing materially in some of these respects from the wayward manifestations peculiar to the action of rhus. Like the latter, arnica must be regarded as an irritant poison when applied to the skin, but of less intensity and of less certainty in its action. Its properties reside in an acrid resin and volatile oil. The appearances which follow its use are, no doubt, often mistaken for the immediate effect, or for the sequelæ, of the injury or other affection for which it has been applied. Even the physician sometimes fails to recognize the artificial nature of the eczema which he is called to treat, and to connect it with the prior application of arnica to the skin. The almost universal belief in the harmlessness of the remedy, too, prevents, in most cases, the patient from communicating to the physician the fact of its use before the appearance of the disease. Cases have been recorded in which the inflammation extended below the skin, producing destruction of the tissues.

The *treatment* is the same as that in an eczema of the same grade (page 58). The excessive œdema and hyperæmia require that the leg, if this be the part affected, should be kept in a horizontal position, and that cold, evaporating lotions should be assiduously employed. The course of the dermatitis under treatment is ordinarily brief.

MEDICINAL RASHES.

Under this title may be mentioned *Dermatitis venenata*, as also those forms of inflammation of the skin which follow not only the application to its surface, but the internal administration, of certain drugs used in the treatment of disease. These can be only very briefly considered.

I. *External Applications.*

The substances included in this class do not comprise those which are used in medicine for the express purpose of producing a greater or less degree of dermal inflammation—the so-called rubefacients and vesicants, such as mustard, cantharides, croton oil, tartar emetic, etc.—but those only which are applied to the skin for other purposes.

ARSENIC.—The action of arsenical compounds upon the cutaneous tissues varies greatly in intensity. Among the milder effects of such contact, are the hyperæmia and papulation produced by the application of the pastes, consisting largely of arsenic and quicklime, so commonly used for the removal of superfluous hairs upon the faces of women, and the more extensive and severe forms of dermatitis produced by wearing garments dyed with arsenical pigments, varying in intensity from simple congestion to vesicular and bullous lesions. It is not improbable that such sources of cutaneous inflammation are often overlooked, as arsenic is now largely used in the preparation of coloring matters, not only for garments worn next the skin, but for ladies' cloths, carpets, hangings, etc. Wall papers, wrapping papers, and playing cards containing arsenic, have caused similar effects upon the skin. The severer forms of inflammation produced by the action of this substance upon the hands of workmen employed in the manufacture of the above-named articles, are well known; they are pustular, ulcerative, and gangrenous in character. This very destructive power of arsenic upon the cutaneous tissues is, as is

well known, called into operation by the surgeon in the treatment of lupus, carcinoma, etc.

MERCURY.—The over-stimulating properties of the many preparations of this substance employed in the local treatment of skin diseases, are familiar to all. When employed in the form of a vapor bath, or in the inunction cure for syphilis, the papular inflammation excited upon the skins of some persons often interferes with the continued and proper employment of the remedy.

TAR.—The various tars used upon the skin in the treatment of disease, or for toilet purposes, frequently develop a considerable degree of inflammation, mostly in the form of a folliculitis, but sometimes in that of pustules of large size, a real acne.

SULPHUR.—This is a decided irritant upon many skins, and, when employed as a parasiticide, or otherwise, often gives rise to acute eczematous inflammation.

IODINE.—The tincture of iodine occasionally produces a deep-seated dermatitis beneath the surface upon which it has been painted, and, rarely, a milder form of inflammation spreading widely from such centres of application.

BALM OF GILEAD. (*Populus candicans*).—A tincture of the buds of this tree is, in some parts of the country, used as a domestic remedy for sprains and bruises. It produces at times a dermatitis closely resembling that caused by arnica.

CHRY SOPHANIC ACID, OR CRISAROBIN.—This substance, the active principle of Goa powder (both of common use in the treatment of the vegetable parasitic affections, and in that of psoriasis), produces, in addition to its staining the epidermis, a moderate inflammation of the skin, which frequently prevents its further employment. Upon the face it almost always causes marked œdema, and should never be applied to this part.

Here might be mentioned the names of many celebrated quack lotions and ointments, which are now in general use by all classes of people, and which, when applied to the general surface, at times give rise to serious forms of dermatitis.

II. *Internal Remedies.*

The substances which give rise to disturbances of the skin when they are administered internally, can only be mentioned by name, inasmuch as they do not especially belong to the province of surgery. They are:—

ARSENIC:—Erythematous, papular, urticarial, bullous, pustular, and purpuric efflorescences.

BELLADONNA:—Erythema, scarlatiniform rash.

BROMINE:—Macular, papular, pustular, flattened nodular, or acneiform eruption, sometimes bullous.

CHLORAL:—Erythematous, urticarial, and papular forms of efflorescence, occasionally purpuric.

COPAIBA:—Erythematous and urticarial efflorescences combined.

CUBEBS:—Erythematous or papular. (Rare.)

DIGITALIS:—Erythematous or papular. (Uncommon.)

IODINE:—Erythematous, papular, vesicular, pustular, or acneiform efflorescence; sometimes bullous; rarely purpuric.

OPIUM:—Erythematous, finely papular, at times urticarial eruption.

QUININE:—Erythematous and papular, with desquamation; at times urticarial; rarely hemorrhagic.

SALICYLIC ACID:—Erythematous, urticarial; occasionally vesicular and pustular.

TURPENTINE:—Erythematous, papular eruption.

ERUPTIONS FOLLOWING OPERATIONS AND INJURIES.

Attention has of late years been occasionally called to the not infrequent occurrence of rashes and other forms of cutaneous disturbance after surgical operations. This subject of traumatic eruptions has recently received a careful study from Mr. Edward C. Stirling, of London. From his observations, which are published in St. George's Hospital Reports, Vol. X., it appears that there are two classes of such manifestations: one, true scarlatina; the other, comprising erythema, urticaria, and herpes. Of the former he cites sixty-three instances following operations of every degree of severity. The rash appeared within three days after the operation in 78 per cent. of the cases, and in every instance within a week. Of the direct connection between the development of *scarlatina* and the traumatic state there can be little doubt, but it can only be explained on the supposition of some peculiarly favorable receptivity to the poison induced by the operation. The course of the disease differs only in unimportant respects from that of ordinary scarlet fever. The other forms of eruption which have been observed after operations and injuries are: (1) An *erythema*, or *roscola*, of more or less general distribution, resembling very closely the rash of scarlet fever, but lacking all other essential characteristics of that disease, and subsiding in the course of twenty-four or forty-eight hours; in some cases the erythema has been of a papular type; (2) *Urticarial* and *herpetic* forms of efflorescence, which are not as frequent as the erythematous. They have been observed even after simple catheterization. The occurrence of such traumatic eruptions has been accounted for on the hypothesis of absorption of the inflammatory products of the wound, or by so-called reflex irritation. They are not to be confounded with the cutaneous manifestations of septicæmia.

ECZEMA.

Eczema is an inflammatory affection of the skin, acute or chronic in course, characterized by a great variety of surface lesions, and accompanied by itching. It presents a number of distinct clinical varieties according to the stage which may be under observation, and which may be recognized under the appropriate titles: *Eczema erythematosum*, *Eczema papulosum*, *Eczema vesiculosum*, *Eczema madidans*, *Eczema pustulosum*, and *Eczema squamosum*.

ECZEMA ERYTHEMATOSUM.—In this, the mildest grade of the disease, as far as the anatomical changes in the cutaneous tissues are concerned, we have a simple reddening of the skin, either in the form of minute points and larger maculæ, or distributed over larger surfaces, due to a hyperæmic state of the capillaries which supply the parts affected. This condition, accompanied by heat and itching, may exist as a simple erythema for a few days, and may fade away, leaving only a slight desquamation behind. If it persist longer, however, a thickening of the reddened skin, which may be recognized by touch, will follow, due to an exudation of cells and serum from the enlarged

vessels, and this condition may last indefinitely. It may disappear by re-absorption of the exudation, or may be developed into more advanced forms of the affection.

ECZEMA PAPULOSUM.—This is characterized by the development of red elevations, varying in size from that of a pin's head to that of a small pea, scattered more or less sparsely over the affected surface, or closely arranged in groups. These papules are produced by the distension and elevation of the papillæ by an exudation, from the greatly enlarged vascular loops within them, of serum and cells, and, although apparently devoid of free fluid, they will, if their outer horny layer of epithelium be pierced with a needle, allow a minute drop of serum to exude. These papules may, individually, last a few days only, or for much longer periods, and they may disappear by absorption without further transformation; or their tips may be excoriated by the scratching which the attending itching provokes, and this may give rise to the establishment of serous and hemorrhagic crusts; or they may become converted into more advanced forms of efflorescence, viz., the vesicle or pustule. This variety of eczema is still called *lichen* by some dermatologists.

ECZEMA VESICULOSUM.—Vesicles in eczema may appear primarily as such, or may be developed from preceding papules. The exudation of serum increases within the papillæ, oozes up into the mucous layer of the epidermis, pushing apart the cells of the rete and drawing them out into thread-like forms, and finally penetrates to the horny layer, which resists its upward flow. Thus we have formed a chambered or compound vesicle, having its septa made up from the elongated cells of the rete, its base being the lowest cells of the latter, and its roof the horny layer. In this way the papular eczema of to-day may become to-morrow an eczema vesiculosum. The vesicular variety is one of the rarest forms of the disease, notwithstanding that Willan and his followers have regarded this as its typical and elementary lesion. It is always an acute stage. The vesicles may remain as such for a few days, when, their contents becoming absorbed, the overlying roofs of epithelial cells flatten down, and are thrown off finally in the form of scales. Usually, however, this natural process of involution is not followed, for the roofs of the vesicles are either torn off violently by the nails in scratching, or the exudation from below is so great as to burst through the horny epithelial coverings. In either case, an abundance of clear serum oozes from the denuded and inflamed surface, and coagulates in the form of yellowish crusts.

ECZEMA MADIDANS.—When large surfaces are thus deprived of their protecting epithelium, and large tracts of the hyperæmic papillary layer of the skin are exposed, this weeping, moist condition is called *Eczema madidans*. In case the inflammation be of extraordinary intensity, or if the tender, denuded mucous or papillary layer be wounded further by scratching or pressure, bleeding takes place from the enlarged vessels, and we have the formation of hemorrhagic crusts in place of the simple, yellow, serous form of the disease. Beneath these crusts, sooner or later, a new epidermis forms, which for a time remains somewhat reddened and scaly before the integument is restored to its completely normal condition.

ECZEMA PUSTULOSUM.—If, however, the vesicles are not ruptured in this way, by violence or excessive exudation, and if absorption does not take place immediately, their clear contents may become turbid by the penetration within their cavities of pus cells. This transformation of a vesicle into a pustule may take place rapidly, or a sero-purulent exudation may at once push up the

epidermis into pustules. In both ways there is established an *Eczema pustulosum*. So, too, in eczema madidans, the serum oozing from the excoriated surfaces may become purulent, and greenish sero-purulent crusts may then be formed. This condition is also called eczema pustulosum, the extreme grade of eczematous inflammation.

ECZEMA SQUAMOSUM.—In the retrogressive stage of all these forms, the skin may be left for an indefinite time in a reddened condition, with an imperfectly formed epidermis, as shown by the presence of scales, either fine and branny, or adhering in thicker and flaky masses. This condition is known as *Eczema squamosum*.

SYMPTOMS AND COURSE OF ECZEMA.—When any of these forms of eczema has lasted for some time, or when those of short duration have recurred at brief intervals upon the same part of integument, a thickening takes place in the underlying tissues of the latter, due to the presence of immense numbers of round cells in the upper layers of the corium. The skin is firmer to the touch, is less elastic, and is not easily pinched up in folds. This tissue change is called *infiltration*, and it may persist for an indefinite period after the surface lesions, which preceded it, have disappeared. It is always the essential feature of chronic eczema, a measure of the past and future duration of the case in which it occurs. As a later and characteristic manifestation, also, of chronic eczema of long standing, when the skin has lost its elasticity in consequence of this cell infiltration, *cracks* or *fissures*, often extending deeply into the corium, are formed over parts often stretched, as over the joints, and these may give rise to hemorrhagic crusts. In patches of chronic infiltration, too, where the vitality of the skin has been reduced, as upon the lower legs in consequence of impeded circulation, the tissues often undergo ulceration, and the process of repair is extremely slow. The coloring matter of the blood, moreover, is extravasated at times in long-continued eczema of these parts, and permanently stains the cutaneous tissues. Diffused *discolorations* and *cicatrices* of the lower leg, therefore, frequently mark the seat of a former eczema. As a rare complication or sequela of the disease in its chronic varieties, a hypertrophy of the papillæ of the skin, in the form of *papillomatous elevations* of various sizes, may be developed in consequence of the superabundant supply of plastic material.

In its varying phases, then, eczema may present the following lesions: the hyperæmic macule, papule, vesicle, pustule, excoriation, crust, scale, and fissure; and as one or other of these predominates at any moment, we have a so-called eczema erythematosum, papulosum, vesiculosum, madidans, pustulosum, or squamosum. Several of these varieties may be present at the same time upon different or contiguous portions of the skin of an individual, and may change, by development or involution, the one into the other. The disease may apparently begin in any of these forms, excepting eczema squamosum, and may run through its various stages so rapidly, that the early and intermediate ones escape notice. To these, the earlier manifestations, may be added in time more deeply seated tissue-changes, such as cell-infiltration, ulceration, pigmentation, and hypertrophy of the papillæ.

Eczema may be *acute* or *chronic*, in form as well as in course. The former variety is characterized by lesions, acute both in character and duration, which may recur over and over again, and thus protract the history of the case indefinitely, and yet remain acute in type. The characteristic feature of the chronic form is cell infiltration. The two conditions may, therefore occur in combination, acute surface lesions being developed upon old infiltrated patches of skin.

Apart from the multiplicity of its forms, due to the protean character of its lesions, the appearances of eczema vary greatly in individual cases, according to its seat and etiological relations; but space permits the consideration of those varieties only which have direct, practical relations to surgery. Eczema is frequently caused by the use of the *mechanical apparatus* and *chemical applications* to the skin, employed in surgery, resulting from undue *pressure* or *friction*, or, in the latter case, from a *macerating* or *irritating* action upon the surface. Of the former causes we have an example in the acute inflammation produced by the pads and straps of trusses, which often prevents their proper employment, especially in hot weather and in persons habitually disposed to eczema. Much may be done to prevent such disturbance by judicious selection of the material and surface structure of the pad, and by frequent change in the arrangement of the straps which tend to produce chafing. By proper local treatment of the eczematous patches during the night, moreover, the evil effects of the unavoidable use of such apparatus by day may be counteracted, and their constant use may thus be rendered possible. The forms of eczema produced by such appliances are, at first, generally of mild type, the erythematous, readily assuming, however, the condition of eczema madidans in parts where, in addition to the mechanical pressure and friction of the harness, two surfaces of skin are in frequent contact, as in the groin, the opposing faces of the scrotum and thigh, the abdominal folds of old and fat people, etc. At a later period, the cutaneous tissues may become much thickened by cell-infiltration.

Of the ill-effects, in the same direction, of *maceration*, we have illustrations in the action upon many skins of water-dressings and poultices. Eczema thus produced, begins generally in the form of a simple folliculitis, which may be converted into a continuous eczematous dermatitis, or the "madidans" or "pustulosum" variety, or which may extend into the deeper periglandular tissues in the form of furuncular inflammation. Much mischief is often thus produced by the injudicious employment of poultices upon the skin surrounding diseased centres of various kinds. Poultices should therefore be made no larger, nor worn any longer, than the original process under treatment absolutely demands. The legitimate softening action of the poultice may in many instances be obtained by the application of thick layers of lard, without injury to skins readily disposed to this form of inflammation. The same results often follow the application of the rubber bandage, where, in addition to the unrelaxed pressure, we have the parts constantly bathed in the confined perspiration. In such cases, too, we may, by proper treatment of the inflamed skin after the removal of the bandage, at bedtime, be enabled to employ it without interruption throughout the day. By prolonged water-dressings, deep-seated furuncular inflammations of the cutaneous tissues are occasionally produced, the same as those which result from the action of the Priesnitz water-cure upon the skin, the so-called critical eruptions.

Of the other class of applications, those which from their *irritating* effects upon the skin are most likely to produce eczema, the most common in surgical use are ammoniacal liniments, mercurial preparations, carbolic dressings, and arnica. They excite ordinarily the erythematous or papular forms, rarely higher stages of inflammation, unless the employment of the irritant is continued. The repeated application of mercurial ointment is often interfered with by the folliculitis or more diffused dermatitis which it produces, but in the inunction cure of syphilis these ill effects may almost always be prevented by rubbing the ointment into the lower legs the first night, into the thighs the second, the abdomen the third, the sides of the chest the fourth, the upper arms the fifth, the forearms the sixth, the lower legs the seventh night, and so on. By such rotation, the process may be employed continu-

ously for months without exciting eczema. Carbolic acid, when applied in concentrated form to the skin, may produce intense dermatitis, or an eschar of varying depth, and even in the weak solutions of ordinary surgical practice, is capable of exciting a mild eczema upon the hands of the attendants. Arnica, although rarely employed by the surgeon, is of almost universal use in domestic medicine, and is the frequent cause of artificial eczema. (See page 51.)

All these forms of artificial eczema, although ordinarily confined to the parts of the integument under the immediate action of the irritant, may afterwards assume a wider distribution, and may even become chronic in persons liable to the disease.

Eczema from Vaccination.—In addition to the graver forms of dermatitis, occasionally excited by vaccination about the point of inoculation, a true eczematous inflammation is not infrequently developed around its immediate vicinity, and may subsequently occupy a large portion of the vaccinated limb, or be the centre of a more general distribution. The part is sometimes covered with thick sero-purulent crusts of considerable extent, which appear to be continuous with the original vaccine scab, so that it is not at all strange that the belief should be entertained, in such cases, that the cutaneous disease is the result of impure vaccination. Less immediate and more general forms of eczema are also sometimes stimulated into existence during the course of vaccination in children, as the result of the excitement produced in all the tissues by the virus.

TREATMENT OF ECZEMA.—The treatment of all these forms of eczema is usually simple, because the type of affection presented is generally acute in the character both of its lesions and of its course. Often the recognition and removal of the exciting cause is sufficient for the restoration of the skin to health, in a few days. When eczema is produced by friction and pressure of surgical appliances, black wash (R. Hydrargyri chloridi mitis ʒj, Liquoris calcis Oj) should be applied to the affected parts upon a thin cloth, as an evaporating lotion, for half an hour morning and evening, when it is possible to remove the apparatus for so long a time. The cloths should be removed and dipped in the wash every five minutes during the application. If the apparatus can be laid aside during the night, as in the case of hernia, cloths smeared with diachylon ointment¹ may be applied at bedtime to the inflamed parts, after the wash, and may be worn until morning. It may be well before reapplying the apparatus, to dust the affected parts, especially where two folds of skin come in contact, with a powder of zinc oxide and starch (ʒj-ʒj). When the excoriations are healed, or in milder grades of inflammation, a zinc wash may be used (R. Zinci oxidi ʒij, Liquoris calcis fʒviij. M.), sopped on freely with a bit of soft cotton rag, and allowed to dry upon the affected parts. It may be applied as often as the apparatus can be removed for a few minutes. This wash may also be used to harden the skin after the removal of a rubber bandage, at night, or to counteract the excoriations and follicular inflammations induced by its macerating action. For the similar mild effects of water-dressings and poultices, the same remedy is often efficient.

In the graver and more widely diffused forms of eczematous inflammation, produced by the irritants above mentioned, the ordinary methods of treatment

¹ Hebra's formula: R. Olei olivarum optimi, fʒxv; Lithargyri, ʒiiij, ʒvj; Olei lavandulæ, fʒij. The olive oil should first be mixed with two pounds of water and heated over a water-bath; then, while fresh water is constantly added, and the mixture stirred, freshly sifted litharge should be gradually introduced. The whole should be kept in motion until cool, and lastly the oil of lavender should be added. In cool weather, an ounce more of olive oil for every pound of the ointment should be used.

in the acute stages of this affection are of course indicated: namely, the frequent application upon thin cloths of aqueous solutions of lime, carbonate of sodium, or carbolic acid, in the form of evaporating lotions, for an hour several times a day; the use of black wash in the same way for shorter periods, when the parts affected are of limited extent; or the employment of the zinc and lime-water wash above mentioned, sopped on without limit as to frequency. As other and more constant dressings, the powder of zinc and starch may be recommended, to be dusted frequently upon oozing surfaces; and the diachylon ointment, spread thickly upon old linen, and bound tightly upon inflamed surfaces for twenty-four hours, to be renewed as long as the inflammation continues active. By these means an eczema of artificial or extraneous origin may be generally subdued speedily after the exciting cause is removed. Seldom is it necessary to resort to the assistance of internal remedies, if the general condition of the patient be satisfactory. Cooling alkaline draughts, such as those containing the citrate or acetate of potassium, may, if the inflammation be intense or extensive, be occasionally found of service.

SURGICAL SEQUELÆ OF ECZEMA.—In another point of view, eczema is an affection of practical interest to the surgeon, as being the cause, directly or indirectly, of cutaneous lesions which require his care, lesions which are the result of tissue changes produced at times by the prolonged action of this disease upon the skin. The most common of these sequelæ is *ulceration* of the lower leg. Eczema of this part, especially after middle life, easily assumes the chronic form, and is accompanied by deep cell-infiltration, so that the integument becomes greatly thickened and indurated. In consequence of the impeded circulation in such diseased tissues, and of the natural feebleness of the blood current in the part, they lose their vitality in great measure, and break down readily into a condition of ulceration. The ulcer may be established by the sloughing of a deep-seated portion of the diseased integument, or by the inability of such infiltrated skin to repair the surface tissues removed by an excoriation, accidental or otherwise. Once established, its size and depth may be limited only by the extent of the prior disease in which it is seated. Its course is always indolent, and it is frequently painful and accompanied by great itching of the surrounding skin. It is, perhaps, the most common variety of ulcer met with in out-patient practice.

Fissure of the anus is another affection which is not infrequently caused by chronic eczema of the neighboring parts. A simple but persistent pruritus is generally the starting point of the affection. This, sooner or later, excites an eczema, as the result of the violent rubbing and scratching which the parts receive, in consequence of which the cutaneous tissues in the vicinity of the anus undergo marked changes. The opposing surfaces, with the cleft of the buttocks, may be intensely red and moist, covered with numerous and deep excoriations, and resembling in appearance the inner surfaces of the labia majora. Thickening and impaired mobility of the parts follow this surface inflammation, defecation becomes difficult, and the anus is practically reduced in size, in consequence of the loss of elasticity in its tissues; and, as the final result, a fissure is formed, generally at the anterior or posterior edge of the opening, which, at first superficial, may extend deeply within the opening and become the usual chronic and painful affection described elsewhere.

Another local form of eczema results sometimes in a grave surgical affection of the part, namely, *epithelioma* of the female breast. Chronic eczema of the nipple is well known to be one of the most stubborn forms of this disease, and a frequent complication of nursing. The disease may occur, however, in the breast independently of this function, even in its virgin state.

The ordinary and diverse appearances of this local variety of eczema need not be described in this connection, but in rare instances, the nipple and areola present the peculiar, raw, red, and oozing phase of the disease for an indefinite period, the epithelium refusing to form anew. All means known in the therapeutics of eczema are tried in vain: no permanent process of repair is established. The part may continue in this state of rawness for years, more or less of the time temporarily covered with a protecting crust or semiformed epithelium, until it is finally discovered that the disease is no longer an eczema, but cancer.¹ This passage of a simple chronic inflammatory condition into a form of carcinoma is not without parallel. The transformation of papillary hypertrophy, in several forms, and of lupus tissue, into cancer, are well recognized examples of such change of character in chronic affections of the cutaneous tissue.

The more general forms of eczema, too, not unfrequently give rise to the development of *furuncles* and *abscesses* which demand surgical treatment. As the result of the long-continued irritation of the skin, and of the consequent violent abuse which, in the form of scratching, it so often receives from the patient in the course of chronic varieties of the disease, it is not at all uncommon for severe furuncular inflammation to occur over considerable surfaces, and to continue for a long time after the primary affection has disappeared. This condition is especially noticed in connection with the artificial eczema of chronic and extensive scabies. Deeper-seated inflammation in the form of small abscesses, too, sometimes accompanies, in children, both acute and chronic eczema, especially upon the scalp. This is rarely observed, however, when the patient is otherwise in good condition, or when the skin has not been long the subject of direct abuse.

ACNE.

Acne only falls within the province of surgery in its more severe manifestations. This follicular or peri-follicular inflammation involves, at times, the cutaneous tissues much more extensively, producing deep-seated infiltration in the form of firm indurations which can be felt beneath the surface, or elevations, varying in size from that of a bullet to that of a small walnut, which last for many weeks, and which disappear either by suppuration and tardy surface discharge, or by reabsorption. Sometimes large tracts of the skin are thickly occupied by such forms of deep inflammation, producing great thickening of such parts, and irregularities of surface. The projecting nodules and tubercles are generally of a dull red or purplish color, and on disappearance are replaced by irregularly shaped depressions or scars, which remain as permanent disfigurements. The parts thus affected are generally the sides of the face and neck, and the back of the neck, although the whole face may be similarly affected in some cases, as well as the upper part of the chest, both before and behind. This form of the affection, called, at times, *Acne indurata* or *inveterata*, may be the termination of any case of common juvenile acne which prolongs itself indefinitely, and may occur in any individual thus affected, though otherwise apparently in perfect health. It affects females as well as males. Occasionally it is associated with general deterioration of health, and may cover extensive tracts of the skin; it is then called *Acne cachecticorum*. In acne of the bearded face, "non-parasitic sycosis," so-called, the same deep-seated follicular forms of inflammation occur.

¹ Sir James Paget calls especial attention to the affection in St. Bartholomew's Hospital Reports, vol. x., 1874.

TREATMENT OF ACNE. — Against all these graver lesions, the ordinary external applications, which may be generally used with such beneficial results in ordinary acne, are of no avail, and resort to very stimulating or caustic preparations is necessary to hasten the reabsorption of the deep-seated infiltration. In these cases, however, much more expeditious results are generally obtained by the early and free use of the sharp-pointed bistoury. This should be inserted deeply into the nodular abscesses and extensive infiltrated tracts, and numerous openings should be thus established for the evacuation of pus and blood. Cold water fomentations and pressure may be applied to check the excessive hemorrhage, which is sometimes very free, though of advantage to the hyperemic tissues. To the boggy and more superficial lesions, the curette may often be applied with benefit. This operation should be employed daily, as long as the deep-seated suppuration and great engorgement of the cutaneous and subcutaneous tissues exist, and should be repeated with each new development. In this way the most serious forms of the disease may be, in a comparatively short time, reduced to the ordinary manifestations which yield to simpler means of cure. The exaggerated forms of follicular inflammation, associated with *Rosacea* and *Sycosis*, are to be treated in the same way.

HYPERTROPHIES.

KERATOSIS SENILIS. (Synonyms: *Keratosis pigmentosa*, Neumann; *Verruca senilis*, Hebra and Kaposi.)—Under the term *Keratosis*, Lebert described the hypertrophies of the epithelial and papillary structures of the integument, and the same generic name has been used, in a more restricted sense, by the American Dermatological Association in its scheme of nomenclature, to signify, under the title *Keratosis pilaris*, the heaped-up collections of epidermal cells around the mouths of the hair follicles, ordinarily called *Lichen pilaris*, and the affection now to be considered. Neumann describes it under the name *Keratosis pigmentosa*, but this is not very appropriate, as the increase of pigment, although highly characteristic, is not always present. The term *Verruca*, too, is not correct, as the papillary hypertrophy, the essential element of wart growth, is, in this affection, mainly wanting.

It first shows itself in the form of collections of scales, slightly elevated above the general surface, of somewhat darker color than the surrounding skin, of an irregularly circular or oval outline, resembling in fact, without close inspection, freckles of unusual size and tint. The surface of these spots is sometimes shining and smooth, sometimes dry and covered with minute, lightly adherent scales. They are without sensation, and attract little attention at first, although seated generally, and in greatest abundance, upon the most conspicuous parts of the person, namely, the upper half of the face and the backs of the hands. They may also appear over more extensive areas, the forearms and chest especially. Gradually they become more noticeable by increase in elevation and depth of color, but their development is very slow, and years may pass before they have attained sufficient growth to become troublesome. In their most advanced condition, they present elevations an eighth of an inch above the general surface, consisting of dry, horn-like scales, which vary in color from the faintest yellow to the deepest black, and which may be removed with a little violence by the nail or a blunt-edged instrument, leaving exposed a superficial excoriation, either smooth or exhibiting minute conical elevations, which are enlarged sebaceous glands. Examined by the microscope, according to Neumann, the underlying and surrounding tissues present the ordinary appearances of senile atrophy, and

an accumulation of pigment in granular form about the vessels. The sebaceous glands are often enlarged, and their mouths plugged or obstructed, so that they project above the surface of the skin in the form of wart-like elevations when the overlying epidermal scales are removed. The growths differ, therefore, from the true wart, in the natural condition of the cutaneous papillæ, the mass of the excrescences being composed of horny epithelial cells more or less pigmented. When fully developed they may be a third or half an inch in diameter, and they have generally a flat surface. They may occur singly or in considerable numbers, even upon the face or hands, and they give to these parts a peculiar appearance, suggesting, in connection with the age of the patient at which they attain their fullest development, the corresponding tegumentary changes in the bark of an old tree. They rarely appear before the age of fifty, and are seldom very conspicuous before that of sixty-five or seventy. They are much less likely to develop upon persons who have kept their sebaceous glands and cuticle in proper order through life, by sufficient use of soap, than upon those who have neglected this precaution. When very prominent, they are easily knocked off, so that the hands especially often present excoriated, bleeding surfaces when the growths upon them are numerous. The scales, when reproduced, are then more or less discolored also by the admixture of blood pigment.

The *prognosis* in the case of such simple collections of epidermal scales would naturally seem to be most favorable, and so it is if treatment be resorted to in good time; but the most simple changes in the cutaneous tissues of the face, in old people, are always to be held under suspicion. A wart or mole which has existed through life, a more recent accumulation of sebaceous material or of hardened scales, may eventually be transformed into epitheliomatous disease. So this affection is a very common starting-point of this form of cancer. The transition from this simple epidermal hypertrophy to the more serious new-growth, is unmarked by any striking change in the condition of the part. The patient's attention is finally attracted to the fact that the wart is not as firmly fixed as formerly, or that the tissues beneath are softer or more boggy when it is pressed upon, or that instead of having a covering of dry scales, it is becoming a crust or scab, or that this is enlarging at a more rapid rate, or that the part is no longer without sensation. Seeking professional advice on these accounts, he is told that the disease is no longer the harmless disfigurement which he has so long accustomed himself to, but an epithelioma. Such is the final history of keratosis senilis in many cases; such the beginning of a large proportion of superficial cancers of the face in old people.

Treatment.—In the earliest stages of this affection, it will be sufficient to wash the parts daily with soap and water, to keep under restraint the tendency to accumulation of epidermal cells. Generally the use of a little sweet oil, rubbed into the patch and allowed to remain for a few minutes before applying the soap, will make its removal easier. When the growths are thicker and firmer, and when there is much pigment change, it is well to use upon them, overnight, some fatty material like lard or diachylon ointment, in the form of a plaster, and to rub into them in the morning, on a piece of flannel cloth, some of the strong soaps, like domestic soft soap, or *sapo viridis*, or their solutions in alcohol. Water is next to be rubbed in until a thorough lather is made, which is then to be washed off. Should any excoriations thus be produced, they may be protected by a patch of diachylon ointment until healed. In this way the ordinary growths may be gradually thinned and made to disappear, but the parts will always require extra care and washing subsequently. If epidermal masses are unusually prominent, or if the sebaceous glands are involved to any great degree, severer measures are called for. Concentrated nitric acid may be bored into the underlying tissues upon

a sharply pointed stick, or the sharp spoon or curette may be used to scrape out at once all diseased elements. As soon as any suspicion of transition to epitheliomatous growth arises, the part should be dealt with according to the rules for treatment in that affection.

CALLOSITIES. (Synonyms: *Tylosis*; *Tyloma*; *Callus*.)—Callosities are thickenings of the cuticle in the form of flattened elevations of irregular shape and size, of a translucent, pale yellowish color, and of firm, dense texture. Their surface presents the ordinary markings of the external skin, but with less distinctness than the surrounding parts, from which they rise without sharply defined borders. They are developed by constant or frequent pressure, or by friction, or by contact with over-heated or irritating substances, and they are formed most readily over parts in which the pressure from without is opposed by the counter-pressure of prominent bony protuberances immediately beneath the skin. The appearance of callosities varies according to their seat and the nature of the external conditions under which they are produced. With the exception of the soles and the sides of the feet, where they are of frequent occurrence, owing to the uneven distribution of pressure which is caused by ill-fitting shoes, and to which all classes of persons are liable, their most common seats are the hands of mechanics who constantly use in their work a limited number of tools. Thus the hammer of the blacksmith and carpenter, the awl of the shoemaker, the shears of the tailor, etc., makes each its own peculiar callus, which is easily recognized by its seat and shape. Lighter employments, too, may produce callosities, as the fingers of the type-setter and the player on stringed instruments show. When once formed, they serve as a shield to protect the sensitive parts beneath them, and they last indefinitely, as long as the pressure which excited them is constantly exercised. When this is omitted for any considerable time, they either gradually disappear by the normal process of epithelial desquamation, or are easily detached as a whole, leaving the cuticle beneath them of its natural thickness. They seldom cause any ill-effects: a slight blunting of sensibility in the parts affected; a diminished freedom of motion, when extensive and seated upon palmar surfaces; or a disposition to form fissures over the flexures of joints, being those ordinarily observed. Occasionally, however, they excite an inflammation of the underlying cutaneous tissues, with attendant throbbing, heat, and pain, followed by suppuration, by which the horny mass is lifted up and finally thrown off.

Treatment.—Surgical interference with callosities is seldom called for, except in case of painful fissures through or suppurative inflammation beneath them. In the former condition, the parts are to be kept covered as constantly as possible with softening dressings, such as diachylon ointment spread thickly upon cloth, warm fomentations, etc. Sometimes the fissure, when deep, can be made to heal only by preventing all motion of the part by strapping it with sticking plaster, so that its opposite walls shall be held in continuous apposition. The corium surrounding and underlying the thickened epidermal structures is often in a state of constant hyperæmia. When to this condition a true inflammatory condition is added, no time should be lost in dividing the thickened epidermal layer above the abscess, and allowing its contents to escape; otherwise the pus may burrow deeply, and give rise to serious disturbances in the part. When the hypertrophy is excessive, the upper layers of epithelium may be frequently shaved off, as in the case of corns.

CLAVUS. (Synonym: *Corn*.)—The corn is also a callosity, or thickening of the horny layer of the epidermis; somewhat elevated above the surrounding surface; of flattened, circular, or hemispherical shape above, extending as a

conical or wedge-shaped mass below the ordinary level of the cuticle, and encroaching upon the corium below. When driven by pressure down upon the sensitive papillary layer, it is evident that the corn must cause pain, and it may in time produce atrophy of the underlying papillæ. Corns, too, are developed by pressure, and generally upon parts immediately above prominent protuberances of bone. The centre of the growth, the part of earliest formation, which forms the apex of the cone-shaped, downward projection of hardened epithelial cells, is called the "core." Corns may be caused by the direct pressure of an ill-fitting boot upon any portion of the surface of the foot in contact with it, or from two opposing surfaces of the skin being unduly pressed together, as in the case of the corns which occur between the toes. It is possible, however, for corns to arise without marked pressure, or spontaneously, as it is said, upon the hands as well as upon the feet. When situated between the toes, the appearance of these growths is quite unlike that of the yellow, horny masses which present themselves elsewhere, being soft, flaccid, and white, owing to partial maceration from the confined moisture of the parts; here they are called "soft corns." All corns are painful upon pressure, the wedge of hardened cells being driven down as a foreign body upon "the quick," and they are more painful when the surrounding and underlying tissues are temporarily distended with blood from overheating, or from inflammation, to which they are liable from oft-repeated irritation. The pain of an "inflamed corn" is excessive when pus is imprisoned beneath the hardened mass.

Treatment.—As corns generally arise from tight or ill-fitting shoes, much may be done for their relief, or even removal, by the disuse of such coverings. Pressure should be taken off from the parts affected, by the use of thick rings of felt. Corns may be softened and soothed by frequent soaking in warm water or saleratus water, when the outer layer of the growth can be removed by scraping, or the whole corn may be dug out with the point of a knife. Softening plasters made of pitch or diachylon are sometimes used for the same purpose. The hardening process, on the other hand, may be often employed with advantage; painting the surface of the corn at bedtime with tincture of iodine, or with a strong solution of chromate of potassium, and removing with a blunt knife the upper layers of the growth thus acted upon, before the next application. Nitrate of silver may be used for the same purpose, especially upon corns situated between the toes, the opposing surfaces here being kept constantly apart by bits of linen cloth dusted with starch powder, or with equal parts of starch and oxide of zinc. The inflamed corn should be treated with caution, by the horizontal position and complete rest of the foot, and by fomentations or leeches, if necessary. Cutting in this condition sometimes leads to serious results, such as inflammation of the bursa, which is often found beneath the corn, and the patient may be attacked by lymphangitis, erysipelas, or gangrene.

HORNS. (Synonym: *Cornu cutaneum*.)—Human horns are outgrowths of epidermal tissue of various shapes and sizes, closely resembling, when they attain any considerable length, the analogous formations upon the heads of some ruminants. Their structure is dense, like the nail; their color is yellow or gray, brown or blackish; their surface is more or less smooth, and marked by parallel, longitudinal grooves; their shape is conical, upon a broad base, or elongated and cylindrical, more or less twisted and bent, and terminating in a blunt or pointed tip. On cross section, they are circular, irregularly oval, or angular, and deeply furrowed. Their maximum diameter may be one or two inches, and their length, in exceptional instances, possibly half a foot. They may be single, or may occur in considerable numbers, and their

seat may be almost any part of the cutaneous surface. They most commonly are found upon the scalp and face, but have in several instances been observed upon the glans penis. Although affecting both sexes mostly after middle life, they occasionally originate between the twentieth and thirtieth years. They are of slow growth, and cause little trouble, except when, on account of their excessive length or situation, they are liable to frequent knocks; in which case they may be more or less detached from their seat, or may even be wholly torn away. When the latter takes place, they are almost always reproduced. Their base is also the seat at times of inflammation and pain from violence to the horn itself. The anatomy of these growths is simple. There are hyperplasy and cornification of the epidermal cells, with more or less hypertrophy of the underlying papillæ; examined by the microscope, the cells are seen to form greatly elongated columns arranged in concentric form around what, as the result of drying and hardening, has become a central tubular cavity, transverse sections resembling the peculiar epithelial grouping in epithelioma. The hypertrophied papillæ are often found extending up into the horn for considerable distances with enlarged vessels, as would indeed seem necessary for the rapid development which these growths sometimes assume. In some cases, the horn may take its origin, not from the papillæ and over-lying surface-rete, but from the inversion of the latter which forms the lining of the sebaceous glands. Thus an old sebaceous cyst may become the starting point and base of a horn. Condylomata and other warty growths may also develop into horns, and the bases of these, in turn, as of other keratoses, may become the seat of epithelioma.

Treatment.—Owing to the strong tendency exhibited by these growths to repeated reproduction after spontaneous or accidental removal, their simple excision by the knife does not result in permanent cure, unless the base or papillary matrix be removed at the same time to a considerable depth. In place of the latter step, it is sufficient and more simple, after pulling off the horn, to thoroughly cauterize the base with caustic potassa or chloride of zinc. If the growth originate from an atheromatous cyst, the walls of the latter are to be dissected out, or entirely destroyed by cauterizing them in the same way.

WARTS. (Synonym: *Verruca*.)—Warts are firm elevations of various shapes upon the surface of the skin, due to hypertrophy both of its papillary and epidermal layers. Several distinct kinds are recognized. The ordinary variety, *Verruca vulgaris*, as it is termed, occurs mostly upon the hands of children, although it may affect any age, and may be met with in other parts of the surface, in the form of flattened or semi-globular elevations, varying in size from that of a mustard-seed to that of a dime. At first of the color of the surrounding skin, and little harder than the same, warts become firmer with their growth, and their surface assumes somewhat the appearance in roughness and color of a callus. As their elevation becomes more marked, the overlying epidermis may disappear, leaving the greatly elongated papillæ capped by hardened, epidermal cells, to project as a group of pointed cones surrounded by a wall of thickened cuticle. This is the “seed wart” of popular language. The interspaces between the points of the papillæ retain the dirt, and allow the wart to assume on this account a diversity of colorings. It may remain in this or any of its earlier phases of development for an indefinite period, and is capable of spontaneous disappearance at any stage. Warts of this kind may appear singly, or in great numbers, and may attain a considerable size with much rapidity. The backs of the hands and fingers, for instance, may present a hundred or more at one time. If left to themselves, they cause no trouble except from their unsightliness, and undergo

no further changes except possibly those of spontaneous involution. If picked, or otherwise treated with violence, those which have lost their protecting epidermis bleed easily from the exposed papillæ, as their vascular plexus is often greatly enlarged. There is no ground for the popular belief that this blood will induce the development of other warts upon parts which it touches, or that warts are in any sense contagious.

Another variety is known as the *filiform* wart, presenting a fringe of fine, elongated, thread-like growths above the common level of the skin, arranged either in narrow lines, as along the free edges of the nails, or in patches of small size, like plush in texture. These are enormously elongated and attenuated papillæ without the protecting rim of epidermis, as in those first mentioned.

The "smooth, flat wart," which is but slightly elevated above the surface, and without abrupt edges; which never loses its protecting epidermis; and which is inconspicuous until late in life, when it becomes rough and possibly pigmented, is the *Verruca plana*.

The *digitate* wart, so called, is situated upon the scalp. It consists of numerous projecting protuberances, more or less tightly pressed together laterally, and appressed or standing out at the periphery as individual rays. These are often quite vascular, and bleed easily when hit by the comb, and are never firm and hard like warts elsewhere. They vary in size from that of a small pea to that of a dime, and they occur singly, or in small numbers only.

These are the true warts, and their anatomy is: first an enlargement of the papillæ and their bloodvessels, and then a hyperplasy of the rete above them, with a corresponding thickening or heaping up of the horny cells of the outer layer of the cuticle. As to their causation we know nothing. Most common in childhood, they appear at any age.

There are other growths upon the skin which are regarded by some pathologists as warts, but which are quite unlike those above described. Among these are the congenital forms (more properly called *Nævus verrucosus*), which are occasionally seen at birth, but which more commonly appear later in life, and generally become more or less pigmented, and subsequently hairy. Such warty nævi occupy at times considerable portions of the surface, and follow in their distribution the tracks of important cutaneous nerves (*Papilloma neuroticum*), causing in some cases great and persistent deformity. The little, elongated, pedunculated growths which are at times attached in such great numbers to the skin, but which are merely duplications or little herniæ of the integument, are sometimes wrongly regarded as warts (*verruæ charnues*, of the French). The so-called "venereal warts" (although in no way directly of a venereal nature), the *Condylomata acuminata*, have already been described. Precisely similar growths appear also upon parts which have not been irritated by venereal discharges.

Treatment of Warts.—Warts may be most easily and completely cured by excision with the knife or curved scissors. When they are small and soft, the sharp spoon or curette may be used with advantage. These quick methods, however, are frequently impracticable, owing to the objection of the patient and, at times, the great number of the growths, so that a resort to other measures is often a necessity. Simple means will occasionally suffice, such as painting the growths daily with the juice of milkweed (*Asclepias*), with tincture of iodine, or with a solution of perchloride of iron; or applying to them, when moistened, pulverized chloride of ammonium, etc. The rapidity with which they will frequently vanish under such applications, should cause one not to forget the fact that they will often disappear in the same way without any treatment whatever, as after being "charmed." A great number of caustics may be used for the immediate destruction of warts; among

these may be mentioned: strong sulphuric, nitric, hydrochloric, and chromic acids, and caustic potassa. These substances should be used with great care, to insure that they do not come in contact with the surrounding skin, or destroy too deeply the diseased tissues, especially over joints. Their injudicious use may cause deep scars and permanent deformity. Generally one or two applications will destroy the wart. Glacial acetic acid is much less likely to cause trouble than the substances named, and is generally effective. It, like the others, should be applied to the parts on a pointed stick, but it must be used repeatedly at such intervals, daily if possible, as the skin will allow. When applied to the soft warts upon the scalp, it is always successful, and one sitting is sufficient for their complete removal. It is to be repeatedly applied to the growth, for the space of ten or fifteen minutes, when the wart may be readily scraped off with the stick employed in the application of the acid. The hemorrhage which sometimes ensues is readily controlled by pressure.

DISEASES OF THE NAILS.

The surgical affections of the nails are those which are produced both by inflammation of their underlying and surrounding tissues, and by hypertrophy of their own immediate structures. The nails are often greatly altered in appearance, shape, color, thickness, surface-condition, etc., in the course of chronic inflammatory and other affections of the skin in their neighborhood, such as eczema, psoriasis, lichen ruber, ichthyosis, etc.—the tissue changes which characterize these, affecting in time the formative structures of the nail. More acute inflammatory processes may cause the nails to be shed. None of these conditions, however, demand surgical interference, under ordinary circumstances, and they need, therefore, no special mention here.

HYPERTROPHY.—True hypertrophy of the nail can arise only from hypertrophy of the papillæ, or hyperplasy on the part of the matrix, which is expressed by excessive cell formation beneath. In this way thickening of its structure arises—confined to the base, when the matrix only is diseased—but exhibiting itself at the front or lateral edges, when the papillæ of the corresponding portions of the nail-bed are similarly affected. The nail may thus be thickened equally over its whole extent, or may assume a great variety of strange shapes, elevating itself in the form of conical horns, or projecting with various curves and twists beyond its free edge, which is of great thickness. This latter condition is called *Onychogryphosis*. The nail structure becomes opaque, more or less discolored, hardened in parts, or brittle, and easily splintered. If the top of such a horny outgrowth, overlying the matrix or nail-bed, be removed by the knife, we come down upon the tips of the papillæ, projecting to a considerable height above their natural level, and bleeding easily when wounded. It is by the deposit of epidermal cells around these hypertrophied papillæ, as in the formation of *Cornu cutaneum*, that the enormously thickened nail masses are built up. The progress of the hypertrophy is always extremely slow, and its course proportionally long; indeed, when the papillæ are materially enlarged, the process may be said to be permanent, a healthy nail rarely being formed again. Even should the thickened mass be torn off, it is reproduced, just as the cutaneous horn after a similar accident.

The causes of true hypertrophy are not well known. Pressure seems to be an exciting cause, as in the formation of the *callus* (page 63). It is on this account that hypertrophy most commonly affects the nails of the toes, especially of the little and great toes. It is in old people, in whom the epidermal tissues

are readily disposed to overgrowth (*Keratosis senilis*), that the affection attains its greatest development. The effect upon the individual varies with the seat of the hypertrophy. Upon the hands, deformity of the finger tips and blunting of the tactile sense are the chief results, although splitting of the brittle tissue occasionally leads to the formation of painful cracks. Upon the toes, however, a similar degree of deformity interferes with the wearing of proper foot coverings, and pressure leads to inflammation of the underlying or surrounding parts. Lateral hypertrophy, or an increase in the superficial area of the nail, by pressure upon the lateral folds, is one of the causes of that most painful affection, "in-growing toe nail," or *Paronychia lateralis*.

INFLAMMATION OF THE MATRIX. (Synonyms: *Paronychia* ; *Onychia*).—Though hypertrophy of the nail-plate is not always the cause of this inflammation of the fold of the nail, yet, however primarily produced, it presses against the edge of the nail, and produces the same painful effect as if the nail itself were absolutely enlarged. In whatever way induced, the fold near the free margin of the nail becomes red and swollen, and at first somewhat painful on pressure. At a later period, the part suppurates, leaving an ulcer which discharges a fetid fluid ; or red, spongy granulations arise, which are excessively sensitive to the touch, and which grow above and over the surface of the nail. The lateral edge of the nail, thus freed from its fold, seems to dip down into the inflamed bed tissues, and causes intense pain when an ordinary boot is worn, especially during walking. The inflammation extends at times along the whole edge, and on both sides, of the toe nail, and occasionally affects all the intermediate tissues of the part, so that almost any motion becomes intolerable.

Treatment.—For simple hypertrophy, without accompanying inflammation, when the deformity is sufficient to seriously interfere with the uses or proper appearance of the foot, or when it threatens to cause inflammation of its surroundings, removal of the offending portion is necessary. Nails which are greatly thickened and prolonged in the form of claws, and those which are elevated like horns, may be trimmed down to their normal dimensions with strong scissors, with a fine saw, or with the knife, but it must not be forgotten that the elongated vascular papillæ extend upwards into such outgrowths to a considerable extent above the general surface, and that they must at times be cut across in the operation. They, too, should be removed as deeply as possible with scissors, and the bleeding surface should be cauterized with the perchloride of iron. In this way the redevelopment of the exuberant nail tissue may be generally prevented. For lateral hypertrophy without thickening, or for incurving before inflammation has been established, the anterior edges of the nail should be frequently trimmed as closely as possible. Blunt scissors should be introduced as far as possible, without causing pain, beneath the nail at either edge, and a cut should be made obliquely backwards towards the lateral fold. The wedge-shaped piece thus cut, should be removed by the forceps. When inflammation is already established, and suppuration or granulation of the lateral fold exists (*Paronychia lateralis*), mere trimming or paring the nail is of little service. Formerly, the entire nail was under these circumstances commonly torn away from its bed, but this operation is unnecessarily severe, as the same radical result may be obtained by removing only a narrow, marginal portion. After etherizing the patient, the nail is divided with a scalpel from its root to its anterior edge, near the lateral border, by a deep incision. The ingrowing portion is then dissected away from the lateral fold and bed, to its extreme root, and removed. [The operation may be readily performed with sharp-pointed scissors, one

blade of which is thrust beneath the nail, which is thus divided by a single stroke. The offending portion is then removed by avulsion.] If the hypertrophy is marked, or if both edges of the nail are inflamed, the opposite margin should be removed at the same time. The inflammation then rapidly subsides, the wound heals by rest, and nearly the whole nail is left to protect the toe.

A painless method of cure which, though slow, is generally successful, is thus described by Kaposi: A little bundle of charpie, with parallel threads somewhat longer than the nail, is cut and laid upon its upper surface, parallel to the lateral fold. By means of a flat probe the mass is now pushed down, thread after thread, between the swollen and inflamed fold and the edge of the nail. In this way the one is separated from the other, since the bundle of lint rests between them, and the painful pressure is thus relieved. The nail furrow is further bedded all about with additional lint, and then a very narrow strip of sticking plaster is wound about the toe from above downwards, in relation to the inflamed fold, so that this is kept drawn away still further from the edge of the nail. With such a dressing, which when properly applied is not at all painful, the patient can put on his ordinary foot covering and go about with ease. After twenty-four hours, the plaster is carefully taken off, and, after a warm foot-bath, the pledgets of lint are removed. Even after this short interval of a day, it will be noticed that the swelling of the fold is considerably less, and that it is by no means as painful as before, and that already a gaping space has formed between it and the edge of the nail. The dressing is then to be renewed, as on the preceding day. The application of the lint is now still less difficult and painful, as the furrow has become more capacious. In this way, by the repetition of the process, the inflammation, swelling, suppuration, etc., will wholly disappear within the space of from two to four weeks. Exuberant granulations, or those which bleed easily, must often be cut off and cauterized, after which they undergo involution and heal. The result is equally favorable whether the paronychia arises as a consequence of a primary inflammation of the fold of the nail, whereby the latter is relatively too broad, or secondarily, as a result of primary hypertrophy of the nail. In the latter case, the lateral margin of the nail must be cut away from before backwards, which may be done with scarcely any pain, if the fold of the nail has been drawn far enough away from its edge by the process described.

[The term *Paronychia* is commonly applied by surgical writers to the affection otherwise known as panaris, or whitlow, and the name *Onychia* given to ulceration of the matrix. A distinction should be made, too, between the simple "ingrowing nail"—which results from mechanical causes, such as hypertrophy of the nail, or the pressure of a narrow shoe—and the form of ulceration which depends upon disease of the matrix itself, and which is perhaps more often met with in the hand than in the foot; the latter is the true *onychia*, or *onychia maligna*, or, when it occurs in the great toe, the "toe-nail ulcer" of the older writers. It usually occurs in persons depressed in health, and is immediately caused by injury; some of the worst cases which I have seen have resulted from the explosion of fire-crackers. The treatment adapted for "ingrowing nail," whether by packing with lint or cotton, or by excising a segment of the nail, will not commonly prove successful in these cases; a better plan is, after avulsion of the nail, to cauterize the matrix thoroughly with the solid stick of nitrate of silver, or, which is, I think, upon the whole, preferable, to cut the nail short and then apply the powdered nitrate of lead, in the manner recommended by Moerloose, Vanzetti, and Mac Cormac.]

DISEASES OF THE HAIR.

HIRSUTIES. (Synonym: *Hypertrichosis*.)—The natural growth of the hair upon different parts of the body varies in amount according to age, sex, and race. Overgrowth in point of *extent*, may be extremely circumscribed—as upon a hairy naevus or wart—or may be universal; as regards *age*, it may be congenital, or may occur at any time after birth. The hypertrophy may consist in an excessive development of the usual large and long hairs of the scalp, beard, axillæ, and genitals; of the short hairs which cover the general surface; or of the downy (lanugo) hairs upon the face and other parts of the female, which are changed into the strong visible growth characteristic of the male. It is this latter variety of hypertrophy only which demands the frequent aid of the surgeon. For universal hairiness, it may be stated in the beginning, nothing can be done; for the circumscribed forms of hypertrophy, in either sex, connected with pigmented naevi and warty growths, the best treatment, when of moderate size, is excision of the whole growth. When too extensive for such an operation, the hirsuties alone may be treated by the method now to be considered. There is no affection more distressing to a woman than an excessive growth of hair upon the face, none for which she will more persistently seek relief. It may be confined wholly to the upper lip, or to a few sparse tufts or scattered hairs upon or beneath the chin, or to the sides of the cheeks. The mustache may often be long and heavy, and the side whiskers largely developed, while a full strong beard is very rare, and generally associated with universal hirsuties. Such growths are by no means infrequent upon the faces of girls after the age of twenty, and the great majority of cases which present themselves for treatment to the surgeon and dermatologist, occur between the ages of twenty and thirty. These young women are generally in good health, and the hypertrichosis seems to be in no way connected with any apparent disturbance of the sexual apparatus. Later in life, about the climacteric period, the lanugo hairs are apt to increase in size and depth of pigment over similar parts of the face, but women affected with this form of the disease more rarely seek professional advice. With the growth upon the face, there is often, at all ages, a similar development over the sternum and about the nipples. In addition to the deformity to which it gives rise, the presence of a noticeable beard or mustache is apt to produce a morbidly sensitive condition, which prompts the bearer to shun society, and at times develops into a true monomania. The writer knew a lady who had visited surgeons in all the principal cities of the country, in vain search for one who would consent to flay the whole lower half of the face, for the extirpation of the hair growth.

Treatment.—It is only within a short time that a radical method of cure for hirsuties has been known. There were previously but three well-known means for the removal of hair, which could be advised by the surgeon, and these had already, in the majority of cases, been resorted to by the patient. They were not only temporary in their action, but they were often of positive injury. The first of these was the method resorted to by persons of the male sex for the temporary removal of the beard, viz.: the use of the *razor*. The second was the application of *depilatories*, which destroy the hair a little way within the mouth of the follicles, and which therefore retard the reappearance of the growth a little longer than the razor, which cuts it off at the level of the surface. But these depilatories have decided disadvantages; they always, in virtue of their caustic properties, produce more or less irritation or inflammation of the skin to which they are applied, which irritation must tend to the stronger development of the overgrown hairs by feeding

their vitality—just as hirsuties, as is well known, not seldom follows the rubefacient action of a mustard poultice on any part of the body. They most commonly consist of mixtures of quicklime and arsenic, or of sulphides of calcium, barium, etc. An objection common to both them and the razor, is that by the use of either there is substituted for the more delicate and tapering, pointed, primary growth, one which is coarser, and of the same dimensions throughout, and much more conspicuous, and that, when resorted to, the remedy must be used frequently. The third method was *epilation*. The same objection is not applicable to this process, for if the hairs are pulled out “by the roots,” which may be easily done, the new growth, which is delayed much longer than after the use of the first two methods, is still tapering and comparatively delicate. Even this process, however, by constant repetition, which is necessary to keep the hirsuties under control, tends to stimulate to some extent the growth in the neighboring follicles. Yet it is the only one which should be recommended by the surgeon as within the power of the patient to use for herself, or as affording any satisfactory measure of relief, although temporary, without aggravating the deformity against which it is directed. For the circumscribed hirsuties connected with papillary and pigment hypertrophy, when this is of small extent, epilation is a sufficient means of relief.

But none of these measures can possibly effect the desired result, the radical and permanent destruction of the growth, as this can be done only by the obliteration of the hair papilla at the very bottom of the follicle. To accomplish this, American dermatologists have, within the last few years, devised and practised various methods, among which may be mentioned the galvano-cautery, applied within the hair follicle; the attempted introduction of powerful caustics or irritants to the interior of the same; the mechanical destruction of the papilla by rimming out the cavity of the follicle with a triangular glover's needle, etc. But it may be said of all of these that they are unreliable, and therefore unsatisfactory.

It is to Dr. Michel, Professor of Ophthalmology in the Missouri Medical College, that we are principally indebted for the introduction of a method which is both practical and efficient, viz., *electrolysis*. Its success was first demonstrated¹ in the treatment of trichiasis, and its applicability to general hirsuties has since been most successfully established, especially by Dr. Hardaway, of St. Louis, and Dr. Fox, of New York. The necessary apparatus is a galvanic battery of ten or fifteen cells, supplying a current strong enough to decompose water. An excellent instrument for the purpose is the chloride of silver battery of sixteen cells, made by the “Western Electric Manufacturing Company” of New York. It is very compact, free from danger of spilling, and needs refilling only once a year. In addition, there are required a small sponge electrode; a supply of the slender steel needles of various sizes, without barbs, used by dentists for extracting nerves; a proper needle-holder; and two cord conductors, a yard or more in length. The needle is connected with the negative pole of the battery, the sponge electrode with the positive pole. The needle, secured in its holder, is then to be carefully introduced within the hair follicle to be operated on, as far as the papilla, and held there, while with the other hand the moistened sponge electrode is applied to the skin in the immediate vicinity of the part. At once a frothy material is seen to ooze from the mouth of the follicle, around the needle, the product of decomposition of the tissues in contact with its point. This frothing should be allowed to continue for a few seconds, according to the size of the hair to be destroyed, when the sponge electrode should be removed,

¹ St. Louis Clinical Record, October, 1875.

and the needle then withdrawn. The hair should now be removed with forceps, the ease with which it comes away indicating the success of the operation. Should the removal require any force, the needle should be again introduced within the empty follicle, and the process of electrolysis repeated. A considerable amount of pain is experienced during the passage of the current through the tissues, which ceases almost entirely on the removal of the sponge. Sometimes, in addition to the frothing, the skin surrounding the needle is thrown up into an urticarial elevation, and is greatly reddened. Subsequently the follicle may suppurate, or may give exit to a serous discharge, which forms a crust, adhering to the skin above it for a week or two. Sometimes a hard infiltration may be felt beneath the surface for a considerable period. Ordinarily, the after-effects are very trivial. The parts finally return to their natural condition, leaving possibly a minute pit or depression to indicate the seat of the operation. If this has been successful, the hair does not reappear. The degree of success depends largely upon the skill of the operator. Dr. Michel claims that 90 per cent. of the larger hairs are at once and permanently destroyed, but others are satisfied if 50 per cent. are successfully dealt with on the first trial. The operation must be repeated upon those hairs which reappear until all are finally destroyed.

It is a question whether or not the hair should be extracted before inserting the needle. Where the hair is very coarse, so that the mouth of the follicle is well defined after its extraction, it may be better to remove it before inserting the needle; but when the hairs are fine and blonde, their presence is necessary to guide the needle within the follicle to be destroyed. It is easy to make the fine-pointed needle enter the follicle even when the hair remains, and the skilled touch recognizes at once when it has been successfully inserted. Even when the needle cannot be introduced directly within the canal, its point may be made to penetrate the tissue in the immediate vicinity of the papilla, so that the electrolytic action may extend to and comprise this essential point. The subsequent non-resistance to the forceps during extraction shows whether this result has been obtained. In place of the needle, a fine flexible platinum wire, sharply pointed, may be used, as more likely, perhaps, to follow the direction of the hair follicle. The patient should be placed in the strongest available light, but, even under the most favorable conditions, the eyes of the operator will tire after a sitting of an hour or less. Perhaps forty or fifty hairs are as many as can be destroyed at one time with advantage either to the surgeon or to the patient, although the latter, after the first few sittings, generally bears the pain of the process without flinching. When an extensive hirsuties is to be treated, a long time is required for the successful primary removal of the hairs, and some of the follicles will without fail require a repetition of the operation. The fine downy hairs which occur either alone or interspersed with the stronger growth, should not be interfered with until they attain a more conspicuous development.

ELEPHANTIASIS ARABUM.

(Synonyms: *Pachydermia*; *Bucnemia tropica*; *Spargosis*; *Hypersarcosis*; *Morbus Hercules*; *Elephantopus*; *The Rose*; *Barbadoes leg*; *Cochin leg*, etc.)

This Elephantiasis of the Arabian medical writers is in no way related to that of the Greek writers (*Elephantiasis Græcorum*), or true leprosy. It affects principally the lower extremities and the genital parts of both sexes, and in both forms is of common occurrence in the tropical and subtropical regions of either hemisphere, though, as a rare affection, it occurs in all parts of the

world. It may also affect other parts of the body, such as the cheeks, upper extremities, ears, female breasts, etc.

In the *leg*, the disease first shows itself as an erysipelatous inflammation of the part, with swelling of the nearest lymph glands, and general febrile disturbance. The lymph vessels also are tender, and may occasionally be felt as hard cords extending up the leg. The temperature of the part is raised. In consequence of the inflammatory obstruction, lymph and serum are effused, and permeate the cutaneous tissues, giving rise to œdematous swelling. After a time these manifestations disappear, and the part returns apparently to its natural condition; but generally a slight thickening and hardness in the integument remain behind. Sooner or later, another attack of erysipelatous inflammation comes on in the same part, and runs the same course, leaving the skin more decidedly and permanently changed. After a few such attacks, the limb generally begins to assume the unmistakable external appearances of elephantiasis. The local erysipelatous attacks continue, but they are less periodic, and are unaccompanied by general febrile action, while the growth is constantly progressive. The thickening generally begins in the subcutaneous cellular tissue, but it may be at first largely confined to either the upper or lower layers of the corium, the outward appearances of the disease varying greatly according as the superficial tissues of the skin are affected or not. When these escape, the surface may appear perfectly smooth and shining, even if pushed up by large nodular growths beneath it. On the other hand, the papillæ may be enormously elongated, resembling the surface of warts or even the bristles of a brush, or forming large papillomatous tubercles. The pigment cells of the rete may be so largely developed as to give a brown or black color to the surface, or the outer layers of the epidermal cells may accumulate to as great an extent as in *Ichthyosis cornea*. With or without these surface alterations, the essential change in the cutaneous tissues goes on in the deeper parts, viz.: a true hypertrophy of its fibrous elements in the corium and subcutaneous structures. A section through these enormously thickened parts—the skin yielding sometimes clean cuts of four or five inches perpendicular measurement—shows a firm, white, lardaceous looking substance, permeated by serum and lymph. Interposed between the meshes of new fibrous tissue, of which the mass is mainly composed, connective-tissue cells are found in abundance. The cutis is firmly united with the subcutaneous tissues, the normal anatomical boundaries being obliterated. The blood-vessels are enlarged and their walls thickened. The disease affects also the connective tissue around and within the underlying muscles, and, in advanced cases, penetrates to the periosteum. The muscles are found in a state of fatty degeneration and their fasciæ are greatly thickened. In connection with the hypertrophy of the periosteum, new bony material is largely formed, and in this way ankylosis of contiguous bones and of the joints is produced. Thus the disease goes on for years, until the leg may attain enormous dimensions, measuring in circumference, in some cases, 36 inches below the knee and 57 inches at the thigh, and giving rise to a variety of secondary processes. The enormous folds of skin, separated by deep sulci, may by friction become the seat of an eczematous condition; or a true erysipelatous inflammation of the integument may ensue. Ulcers, abscesses, gangrene of the parts may arise; a great and persistent flow of lymph may weaken the patient; the nerves may be so pressed upon as to cause severe neuralgia; disease of the bones may develop; or the great weight and discomfort caused by the tumor may of themselves reduce the patient's strength.

Upon the *genitals*, the progress of the disease is unaccompanied by the characteristic, paroxysmal, inflammatory symptoms which, in its early stages, it presents upon the legs. It begins insidiously, most commonly in the clitoris

or scrotum, or it may affect primarily the labia or penis. The scrotum, especially, is gradually converted into an enormous tumor, which hangs down below the knees, drags down the skin of the abdomen and inguinal region in the form of a narrow pedicle, and buries the penis within its mass, the position of the latter organ being recognized only by a funnel-shaped canal which leads into the mouth of the urethra, and through which the urine finds its passage to the surface. Such growths have been removed, weighing in some instances as much as 165 pounds. The clitoris, too, attains in this way enormous dimensions, hanging down as a globular mass below the knees. The newly formed connective tissue is much softer in the genital varieties than in the crural, and the disease has here been called *Elephantiasis mollis*, from its gelatinous appearance on section.

Another variety of the disease is called *Elephantiasis teleangiectodes*, *Dermatolysis*, or *Cutis pendula*. The skin of considerable portions of the body appears to be too large for the part, and hangs in folds, or in globular masses. Such dependent flaps may feel hard, or soft, and are partly compressible. These hypertrophies, or new-growths, as they are variously regarded by anatomists, are said to be always congenital, and to consist primarily of vascular and connective tissue; they may remain of their original size and character through life, or may develop into elephantoid hypertrophy of the integument, and may extend over large surfaces of the body. They are occasionally observed hanging down from the whole length of the arm, like the dewlap of a cow, and depending from the shoulders and back. The parts to which they are attached are frequently atrophied. According to the preponderance of the vascular over the connective tissue, these growths assume the character of the "vascular spongy tumor," or "cavernous blood tumor," on the one hand, or of the firmer *Molluscum fibrosum*, on the other. In addition to the hard and gelatinous connective tissue which forms the bulk of the tumor, with the new development of bloodvessels, greatly dilated lymph spaces enter into its structure.

CAUSES.—The causes of Elephantiasis Arabum, occurring as an endemic affection, are not known, although many theories have been offered in explanation; among these, the latest, which has recently been advanced in India, is that the disease is due to the presence in the circulating fluids of filariæ, which are supposed to be introduced within the vessels through the agency of mosquitos. Any condition which tends to develop a chronic œdema, will favor the production of this affection. Therefore, in elephantiasis of the leg, varix, chronic eczema, disease of the bones of the part, or any chronic inflammatory process, may be an important factor in sporadic cases, but in the genital forms of the disease, the whole process seems to be passive and inexplicable.

TREATMENT.—The objects to be accomplished in the treatment of *Elephantiasis cruris* are: to prevent the attacks of recurrent erysipelatous inflammation, in the early stages, and to remove the chronic œdema which furnishes the nutritive elements for the hypertrophied tissues. The possibility of effecting a radical cure by ligation of large, afferent, arterial trunks, or the propriety of removing the part by amputation, may also become a question for consideration. The inflammatory attack should be treated by absolute rest of the limb, in an elevated position, and by the use of evaporating lotions, or of warm fomentations. After its subsidence, gradual compression of the hypertrophied part with bandages should be undertaken. These should be applied in the morning, before the patient leaves his bed, beginning with the foot

and proceeding upwards beyond the extent of the swelling, using as much force as can be borne without pain. At times it is necessary to treat an incidental eczema upon the surface, or ulceration of the integument, before compression can be properly employed. More favorable results are to be expected from the use of the rubber bandage than were obtained before its introduction, because it can be readily applied by the patient himself, and because it continues to exert its constricting action throughout the day, whereas bandages made of other materials become relaxed in a few hours, and must be readjusted several times during the day to be of service. By the use of the elastic bandage the size of the limb may be gradually reduced to a considerable extent, the progress of the disease checked, and locomotion made much easier. It of course cannot be laid aside except during the night, and must be worn through life. As a radical measure of relief, ligation of the femoral artery has been performed in numerous cases; first by Dr. Carnochan, of New York, in 1857, and since then by surgeons everywhere. The shutting off of so large a supply of nutritive fluid as this operation effects, with the long consequent rest of the limb in a horizontal position, reduces its bulk of course, but, as the collateral circulation is in process of time established, and as the leg is used, the disease renews its activity, and the part may grow to exceed its former dimensions. An analysis made by Wernher of the results of this operation upon large arteries, in 32 cases, showed in all an immediate reduction of the size of the limb, but the relief was permanent in three cases only. Compression of the main artery is attended by similar results. [Leonard, of Bristol, found that of 69 operations, 40 ended in recovery (3 of these after digital compression of the artery); relief was afforded in 13 more; and only 16 were entirely unsuccessful.] Dr. Morton, of Philadelphia, has tried¹ nerve section in a case in which ligation of the femoral artery had been performed two years previously without permanent benefit. An inch and a half was cut out from the sciatic nerve at about the middle of the thigh, and the operation was followed within six weeks by a reduction of eight and a half inches in the circumference of the limb. Amputation has also been resorted to in many cases, but the results have generally been unfavorable.

In *elephantiasis of the genitals*, compression is impracticable, but excision is generally successful. The enormous pendent growths met with in the female organs are easily removed by simple amputation. When the scrotum is affected, the following directions for a plastic operation, given by Pruner, as quoted by Kaposi,² may be followed. In case the penis is still free, the patient having been placed in position for lithotomy, "whereby the tumor is properly supported and the penis bent backwards, above, two lateral, semilunar incisions are made from the end of the scrotal raphe, where it is in contact with the root of the penis, towards the margin of the anus. These incisions mark out the two oval flaps which, when carefully dissected up, form the artificial scrotum. After these two flaps have been made, the testicles and the spermatic cords are freed by downward cuts, on each side, at right angles to the flaps, and by careful separation of the tissues beneath; and any existing complications, as hydrocele, for instance, having been removed, then the portion of the tumor attached to the perineum is carefully and thoroughly excised, when the whole mass of the tumor falls away. . . . The testes and spermatic cords, which, in the mean time, have been wrapped up in a warm cloth, moistened with mucilage, and placed upon the abdomen, are now brought down and inclosed in the two lateral flaps, which are brought into

¹ Philadelphia Medical Times, January 19, 1878, and Surgery in the Pennsylvania Hospital, p. 118. Philadelphia, 1880.

² Hebra and Kaposi on Diseases of the Skin (New Sydenham Society's edition), vol. iii. p. 157.

the closest apposition, and retained there by means of stitches, sticking plaster, etc. . . . If, however, the penis has already become buried in the tumor, then the operation undergoes several modifications. These are the formation of an oblong, quadrangular flap of reserve to cover the penis, the formation of two oval lateral flaps . . . to form an artificial scrotum, the removal of the pouch formed by the original covering of the penis, the separation of the testes and spermatic cords from the surrounding mass, etc.” Dr. Osgood,¹ of the Foochow Hospital, reports sixty successful operations of this character in China, many of the tumors having been of enormous size. [Of 28 cases operated on by Fayrer, 22 ended in recovery and 6 in death: one from shock, and the remainder from pyæmia. The same surgeon, from an analysis of 193 cases, gives the general death-rate of the operation as 18 per cent. To diminish bleeding during the operation, the part should be elevated for some hours previously, and the neck of the tumor should be compressed with a clamp (Fayrer), a running noose (Maetier), or an Esmarch’s tube as employed by Partridge and Cayley, of Calcutta.]

In *Elephantiasis teleangiectodes* the vascular growths may be treated in their early stages as large nævi, according to the ordinary rules of surgery; when, however, they are of any considerable extent, but little benefit can be obtained from any method of treatment.

ROSACEA HYPERTROPHICA.

Closely allied, in its most advanced stages, to the elephantiasis above described, is the affection commonly called *Acne rosacea*. This title is not a good one, because the acne often found associated with the affection is not an essential part of it. This is a chronic disease of the integument of the face, characterized by redness, by enlargement of the capillary vessels, and by hypertrophy of the cutaneous connective tissue, in the form either of prominent elevations, or of general thickening of the skin. The seat of the disease is principally the nose, but it may extend to the chin, cheeks, and forehead, and, in rare instances, to the scalp. The first evidence of its appearance is a redness, a chronic blush, as it were, of the end of the nose, which Hebra well describes as looking as if “frost-bitten.” At a later period, there will almost always be associated with this redness an enlargement of the superficial capillaries of the nose and cheeks, appearing as a network of bright-red vessels. In this form, the disease is a frequent affection, in greater or less degree, with women, and more so than that which is accompanied by development of true acneiform inflammation of the follicles, and by seborrhœa. The redness varies in degree and tint, according to the temperature, the time of day, the condition of the patient, etc., being sometimes of a fiery scarlet, and at other times of a livid, purplish hue. This condition may last indefinitely, and may never progress to the more advanced forms of the affection. In the second degree, firm, nodular elevations, varying in size from that of a small to that of a large pea, are developed upon the hyperæmic skin of the nose and cheeks—which are themselves red—and may soften and be resolved, or may terminate in permanently organized protuberances. In the highest degree, and after long continuance of these earlier forms, the affection presents more prominent outgrowths from the surface of the skin, varying in shape or size, and elastic to the touch; or the tip of the nose or the alæ may take on a similar hypertrophy; or the whole organ may develop to an astonishing size, justifying the expression in common use in Germany—“pound-nose.”

¹ Medical Record, April 8, 1876.

If to this enormous thickening of the integument we add the fiery hue which accompanies it, especially in free drinkers, the enlarged and visible capillaries, the widely distended follicular openings, and, to complete the picture, the numerous comedones, acne pustules, seborrhœa, and scars, we have the immortal nose of Bardolph, as painted¹ by an artist whose descriptions of all things within the compass of his observation have never been equalled.

NATURE AND CAUSES.—The *nature* of the anatomical changes in rosacea is primarily an enlargement and new growth of the vessels of the skin, in its upper portion, and subsequently, hypertrophy of the connective tissue, which, at first jelly-like and elastic, and capable of reabsorption, becomes, in the most advanced forms of the affection, fully organized and firm. We have little positive knowledge of the *causes* of rosacea. In the first stage, it occurs about equally in both sexes, but in its most advanced forms, it affects almost exclusively men beyond middle age. It is often associated, in women, with disturbance of menstruation and with anæmia. Constant exposure to rough weather favors the development of the vascular new growth. That the free use of alcoholic drinks works strongly in the same direction, has been recognized in all ages, as seen in the Latin poets, in the tavern talk of Falstaff and his companions, above referred to, and in the expressions “toddy” and “grog blossoms,” in use to-day.

TREATMENT.—The mild grades of the affection are best treated by such local remedies as are of service in the hyperæmia and follicular inflammation of acne. For the diffused redness, a wash of sulphur and camphor (Sulphuris præcipitati 3ss, tincturæ camphoræ f3ss, alcohol f3vij), applied freely at night, will often gradually give relief, if used in connection with remedies addressed to any general fault of the economy which may exist. The enlarged vessels which ramify so conspicuously just beneath the epidermis, may be destroyed by repeated scarifications with a sharp-edged needle, or much more surely by electrolysis. The nodules, in their earliest stage, may be freely lanced, or scarified, or, when too firmly organized to be relieved by depletion, may be removed by the curette. When the skin is greatly thickened, and when the nose has become monstrous in size, either over its whole extent or at its tip or ala, it may always be reduced to moderate proportions by free excision of the hypertrophied integument. The surgeon must be prepared for free hemorrhage from the vascular new growth. [To avoid bleeding, Ollier recommends the employment of the galvano-cautery.]

KELOID.

Keloid [or Cheloid] is a new growth of fibrous tissue resembling a scar, embedded in or elevated above the skin, arising spontaneously, and generally remaining through life. It has been the custom to divide such growths into the *true* and the *false*, according as the keloid has its origin in the normal skin or in a pre-existing scar, but such distinctions are of little practical consequence, as the growth is the same in both cases. It begins as a flattened and firm, elastic thickening of the skin, or as a slightly elevated prominence of small size, the surface being of a pinkish hue, or paler than the surrounding skin, and covered by a thin, smooth, and shining epidermis. It may be

¹ King Henry IV., First part, Act III. scene 3. Bardolph had then borne his nose eighteen years, according to Prince Hal (Act II. scene 4), and we still find it a conspicuous object in the reign of Henry V.: “all bubukles, and whelks, and knobs, and flames of fire.”

slightly painful on, or independently of, pressure. It grows very slowly, sometimes spreading itself out as a thick, firm plate, with sharply defined edges, embedded in the skin, and movable with it; sometimes rising above it as a bean-like prominence, several lines in height; sometimes sending out ridge-like prolongations from its central mass into the surrounding skin, and presenting the most varied shapes. Years are ordinarily required for its fullest development, and it may attain the size of the palm of a hand. It is, possibly, capable of self-involution, but it never undergoes any other anatomical change, nor exhibits any surface lesions excepting the thinned, smooth epidermis, mostly devoid of hair. Its seat is most frequently the anterior thoracic region, the neighborhood of the sternum particularly, but it may occur on any part of the surface, especially when it arises from pre-existing scars, such as those left behind by acne, leech-bites, etc. Generally single in its development, keloid may occur in numerous patches, as many as twenty or more.

Of its causes, nothing definite is known, observation merely showing that some persons are so prone to the formation of this new growth, that any injury to the skin becomes the seat of its development. The black race is especially disposed to it, the growth attaining an enormous size, in some instances, upon the seat of former injuries to the integument. Anatomically, keloid is found to consist of dense fibrous-tissue new growth, arranged in direction parallel to the surface of the skin. It starts with the development, about the arteries of the corium, of spindle-shaped cells, which become finally fibres. These increasing, make the bundles of fibrous tissue, which press upon, and finally obliterate, the vessels and glandular structures of the skin, until its whole substance is converted into dense fibrous tissue. In the outlying portions, the early development of the new growth may be always studied in the adventitia of the vessels, extending into the apparently healthy structure of the skin to a considerable distance beyond the mass of the tumor. The superficial tissues of the corium, the papillary layer, remain unchanged. In the so-called "false keloid," arising from pre-existing scar tissue, that portion of the growth which occupies the seat of the former cicatrix, is of course without the papillary bodies, superficially, inasmuch as they must have been destroyed in the preceding destructive process; but the remainder of the growth, extending from the original scar as a centre, presents no differences from keloid of spontaneous development. Microscopic investigations of the structure of the starting-point, minute it may be, of the growth, would be the only means in many cases, therefore, of distinguishing one clinical form from the other. From hypertrophied scar tissue proper, keloid is distinguished not only by this absence of the papillary structure, but also by the want, in the former, of parallelism in the arrangement of the fibres, which run in all directions.

TREATMENT.—Although keloid is not destructive of life or of cutaneous tissue, it is an affection which may be called in one sense malignant, inasmuch as it is incapable of cure, and will return repeatedly after excision. It would be useless to call attention to the various remedies which have been advised by writers to check its progress or cause its involution, for no evidence exists that they are capable of exerting action in either direction. Neither is the destruction of the growth, by caustics, or its most careful and apparently complete extirpation by dissection, of avail; the scar tissue which necessarily results always forming a starting point for the re-development of the fibrous-tissue new-growth, which must be pronounced incurable. The only treatment possible, lies in the direction of relief to the pain and itching, which in many cases accompany the disease, especially during its period of active growth. For this purpose, it may be protected from contact with the

air or clothing by the application of soothing plasters, and, in severe paroxysms, subcutaneous injections of morphia may be employed. Generally, however, the patient must be content to bear his affliction without hope of surgical relief.

HYPERTROPHIED SCAR.

The hypertrophied scar may be developed as the immediate sequence of a preceding destructive process, in consequence of protracted cicatrization by which the granulations have time to become organized into firm fibrous tissue, and to thus form well-marked tumors of various shapes—nodular, stellate, reticular, band or ridge-like, etc.; or flat and normal scars may, at some considerable period subsequent to their formation, take on a like hypertrophy, and be transformed into similar disfiguring tumors. Such results, although more likely to follow the destructive action of certain agents upon the cutaneous tissues, may ensue upon any injury to the skin, even the simplest incision, for reasons wholly unaccountable. Such overgrown cicatrices may present a smooth and even surface, but slightly elevated; or ridge-like tumors of great extent and prominence, with pockets and bridges, and of frightful appearance. Their structure differs from keloid growth in several respects, the bundles of fibrous tissue, of which they are composed, running in all directions, so as to form a complex network of slender and broad bands. The papillary layer above is wholly wanting. The bloodvessels are very abundant in the early stages of the growth, but are in old scars no longer pervious.

TREATMENT.—Unfortunately, very little can be done to relieve the disfigurement produced by hypertrophied scars, urgently as patients may request the aid of the surgeon. In exceptional cases, excision followed by a plastic operation, may effect a cure; but excision is almost always followed by the formation of a still larger scar, in consequence of the greater loss of substance, and no certainty can be given the patient that a similar hypertrophy of the new scar may not result. Should there be any keloid element in the original cicatrix, such a result would be inevitable.

FIBROMA.

(Synonyms: *Molluscum fibrosum*; *Molluscum simplex*; *Molluscum non-contagiosum*.)

This form of *Molluscum* differs from *Molluscum contagiosum* in possessing no outlet, nor contents which can be squeezed through such an opening, for it consists of a new growth of connective tissue. It may occur singly, but is often observed in great numbers. In size it varies from that of a pin's head to that of filbert, an egg, or a fist; or may form even larger tumors. In shape it may be flattened, semi-globular, prominent, and attached by a broad base, or may become in time pedunculated. The integument covering it is generally unchanged in appearance, but may be somewhat hyperæmic, and, in rare instances, has been known to ulcerate when the tumor was large and pressed upon on account of its position. The follicles upon the surface are sometimes enlarged and plugged by hardened sebaceous matter. The growth feels somewhat soft and elastic on pressure, or of variable hardness in different parts, when large. The seat of these tumors is by preference the trunk, and upper parts, but they may occur upon any part of the surface, including the scalp, and may cover nearly the whole integument. They develop, too,

within the cavity of the mouth. They begin to show themselves in the majority of cases early in childhood, although they rarely attain any considerable size until adult life. They are capable, when small, of spontaneous involution, leaving a purse-like fold or projection of the skin to mark their former seat; but ordinarily they persist through life, continuing to increase in size indefinitely, or ultimately ceasing to grow. They give rise to no subjective symptoms, and are merely an inconvenience and deformity. The growth consists in its early stage of new connective-tissue cells, which seem to have their origin from the lower layers of the corium, or from the meshes about the fat-cells, and which have a jelly-like softness, but gradually become firmer, until in old tumors they are found converted into firm bundles of fibres. They possess few vessels except at their base. In their anatomy, therefore, they are closely allied to Elephantiasis Arabum. Fibromata, however numerous, have no effect upon the general economy, nor do they undergo malignant degeneration. They may develop even in great multitudes upon persons otherwise perfectly sound.

TREATMENT.—Nothing can be done to arrest the development, or to cause the reabsorption, of fibrous mollusum by external or internal remedies. The only question is of removal by surgical means, and this is not called for except when the growths are very disfiguring, as upon the head, or incommensurable from position or size. When small or appressed and crowded together, they may be scraped away with the sharp spoon or curette, but when of larger size, they must be excised, if their base is broad; or they may be removed also, if they have a slender or peduncular attachment to the surface, by the galvano-cautery or by the ligature. No serious results follow such operations.

XANTHOMA.

(Synonyms: *Xanthelasma*; *Vitiligoidea*; *Fibroma lipomatodes*.)

This is a peculiar condition of the skin, characterized by sharply defined patches or elevations of a yellowish color. Two varieties are recognized by dermatologists: *Xanthoma planum* and *Xanthoma tuberosum*, but they are not distinctly defined. The first, or flat form, occurs chiefly about the eyelids, in the shape of elongated patches, but slightly elevated above the general surface, varying in tint from a pale lemon to a brownish-orange, and in size from a minute point to an inch in length, and a quarter or half inch in width. The skin thus affected feels perfectly normal to the touch, or when pinched up, and its sensations are in no way changed. The surface is smooth and even. These patches occur most frequently upon the eyelids, or upon the nose near the inner canthus, but they may affect other portions of the face, such as the ear, or the neck and the mucous membrane within the mouth. The tubercular variety appears in the form of yellowish papules or nodules, of the size of a pin's head, pea, or bean, or somewhat larger, sharply defined, and not projecting to any great extent above the general surface. These, too, are smooth and soft, and of the same color as the patches of the flat form, with which indeed they sometimes occur simultaneously, or the flat variety may in rare instances develop into the tubercular. The most common seat of the latter is on the fingers and toes, the palms and soles, and the penis. It may occur upon any part of the body. Both forms begin insidiously, increase very slowly, and last generally during life. They are rarely seen in childhood, and more commonly in women than in men. Of the causes of Xanthoma, little or nothing is known. English writers have associated it with a previous history of jaundice in the patient, but in the majority of cases no

such coincidence exists. It is noticeable, however, that in many cases the skin about the eyes in women thus affected is very darkly pigmented, making the light yellow patches of xanthoma more conspicuous. The structure of these growths has been variously interpreted by different observers. Virchow considers them connective-tissue new growths, the cells in the central portion of which have undergone fatty infiltration, while the outer are free from fat, and resemble sarcoma. Kaposi regards them as interstitial new growths of fibrous tissue, with deposits of yellow fat. Geber and Simon, recent observers, maintain, on the other hand, that the growth is a hyperplastic development of the cells of the sebaceous glands proliferating into the fibrous tissues. The *diagnosis* between xanthoma and milium is easy, for nothing resembling the contents of the sebaceous glands can be squeezed from the patch, by incision, as in the latter affection.

TREATMENT.—The growths may be removed, if the patient desire an operation, by the curette or by incision. Owing to the loose texture of the skin about the eyelids, large patches may be easily removed by dissection, and the edges of the wound brought together without subsequent deformity. Care must be taken, however, not to go more deeply into the underlying tissues than is necessary, for fear of possible ectropion. The growths, however, may be safely left to their own course, as they never give rise to anything more serious than disfigurement.

NEUROMA.

This is a name which should be properly applied here to new growths of nerve tissue in the skin. It may perhaps be doubted if such, strictly speaking, occur. Cases have been described of small, multiple, tubercular masses of slow growth, situated in and rising above the skin, which eventually became the seat of intense paroxysmal pain, and which were very sensitive on pressure. The tubercles varied in size from that of a small pea to that of a filbert, were firm and elastic, and sometimes of a pinkish color. They were composed of connective tissue, with more or less of non-medullated nerve fibre. They were apparently closely allied to fibroma, and to the "painful subcutaneous tubercle," which has its seat beneath the skin. In the two cases above referred to,¹ excision of the nerve supplying the affected parts was followed by diminution of pain, and by a reduction in the size of the tumors.

ANGEIOMA.

This is a new growth or hypertrophy of the bloodvessels of the skin, which shows itself in a variety of forms, all being included under the same general title. The simplest of these forms, those which arise during extra-uterine life, are called *teleangiectases*. They are enlargements or new growths, mostly of the superficial capillaries, and are observed sometimes as single or branched vascular twigs, of a bright-red, purplish, or bluish color, situated principally upon the nose and cheeks, especially in rosacea; sometimes as circumscribed, circular patches of the size of a pea or bean, consisting of minute visible vessels radiating from a centre, which is occasionally elevated as a small point or papule of a brilliant scarlet hue (the "spider cancer" of popular language); and sometimes as more prominent nodules, which are turgescient and of a reddish or purplish color. Teleangiectases may first show themselves in early

¹ Duhring's Diseases of the Skin, 2d Edition, page 535.

childhood, but they may appear at any time up to extreme old age. Once developed, they are generally permanent, but the superficial forms are capable of spontaneous involution. Their seat is principally the face, but they occur also upon the neck, breast, backs of the hands, and indeed upon any part of the surface of the body. They may also affect the red border of the lips, and the interior of the mouth.

NÆVUS VASCULARIS.—This variety of angioma is congenital, or becomes apparent immediately after birth. It appears in the form of a diffused discoloration of the surface, varying in tint from a faint pink, through bright scarlet or purple, to a deep indigo, and its size varying from that of a small pea to uniform areas of great extent. The surface may be smooth and even, and but slightly elevated above the surrounding skin, and slightly or not at all turgescient. This is *Nævus flammeus*, *Nævus simplex*, or "*Port-wine mark*." Another form, more deeply seated and composed of larger vessels, is not so uniformly diffused, but prominent, of uneven surface, tumor-like, and compressible. This is *Nævus tuberosus*, *Angioma prominens*, or *Angioma cavernosum*. Both forms generally occur singly, and have their principal seat upon the head, on the scalp, and all parts of the face, are found sometimes upon the trunk and hands, and are seen rarely upon the lower extremities. They are sometimes associated with pigmented and warty nævi. They generally attain a considerable development in the first months of life, and may remain permanently of the size thus acquired. On the other hand, they may take on a more active growth, or may undergo diminution in size, at any subsequent period of life. The deeper-seated forms are especially liable to assume a more active development in later life, extending down into the subcutaneous tissues—muscles, nerves, and bones, even—producing atrophy of the same by pressure of the immense vascular new growth, which becomes converted into a prominent spongy tumor, occupying large districts of the body (see *Elephantiasis teleangiectodes*, page 74).

Anatomically, these growths present great differences in the complexity of their structure. The flat forms of nævus consist simply of an enlargement or new growth of the capillaries of the papillæ and of the upper layer of the corium, with generally some enlarged feeders rising up from the deeper vascular plexus. The variations in their color depend upon the relative predominance of the venous and arterial vessels. In the prominent (tuberosus) forms, not only are the deeper seated trunks enlarged, but the networks connected with the various glandular systems of the skin are implicated, with new development of vessels in the form of pouches and coils, which communicate freely with each other, forming great sponge-like convolutions of bloodvessels, mixed with more or less new growth of connective tissue of the gelatinous kind. In the extreme examples of this sort, we have *Elephantiasis angiomatosa*. The true *Tumor cavernosus*, so called, has a much greater development of the fibrous tissue, which surrounds the vascular new growth with a firm capsule, and sends off shoots from the same between the vessels within, forming partition walls and a firm fibrous skeleton to the whole mass, within which the blood flows in great open channels. The precise anatomical nature of such tumors is a subject of active discussion among pathologists. They are generally confined to the internal organs, but may develop beneath or within the skin, rarely attaining the size of a walnut. They are found in the neighborhood of the saphenous and cephalic veins. Their surface may be the seat of various excrecences.

TREATMENT OF ANGEIOMATA.—For the simple teleangiectases, efforts may be made to destroy the tortuous vascular twigs which ramify so near the sur-

face, by cutting across them freely and repeatedly with a knife or cataract-needle, and by applying to the bleeding points a solution of perchloride of iron, or of nitrate of silver in water, equal parts. This process is not uniformly successful. For the dilated vessels, as well as for the circumscribed and minute nodular forms of the disease, the operation of electrolysis is perhaps the best. A fine needle connected with the negative pole is to be inserted into the channels of the vessels, and a current of ten or fifteen cells employed, a sponge electrode connected with the other pole being applied to the skin near by. (See application of electrolysis in hirsuties, page 71.) The needle is then to be inserted at other points until the whole vascular structure has been destroyed. The application of nitrate of silver or nitric acid to the central nodule often fails to destroy the halo of vessels radiating from it. Small and flat naevi may be treated in the same manner as teleangiectases, but attempts to destroy extensive growths of this kind by scarification, as recommended by Squire for port-wine marks, will not often prove successful. Electrolysis and the galvano-cautery are the most reliable methods to employ. For the deep-seated forms, various means of cure have been practised. Compression, ligation of afferent vessels, injections of styptic solutions are of no avail, and the latter method is dangerous. The galvano-cautery repeatedly applied to one part after another, by means of platinum wire, is often successful. If the action is too intense, sloughing of the tissues and possibly hemorrhage may ensue. Only a small portion of the tumor should be acted upon at one time. Vaccination, performed at several points over the growth, may effect a cure by causing progressive sloughing of the vascular tissue. Small naevi may be destroyed by strong nitric acid, or by caustic potassa; strangulation by ligatures may sometimes be used with advantage, when these can be applied about the base of small tumors; or the thread may be passed beneath the growth, and tied so as to compress the tumor in several parts. In such cases it may be well, after the separation of the strangulated part, to cauterize the exposed base of the naevus so as to prevent its return. Direct excision, too, may be resorted to, care being taken that an abundance of the surrounding skin is included, so as to prevent peripheral return of the growth. The edges of the wound are to be united by sutures. Spontaneous cure is occasionally effected in infancy, by progressive sloughing or ulceration arising of its own accord.

Cavernous tumors may be readily excised, being easily enucleated with their fibrous capsules. Operations for naevus in infancy may be delayed, because spontaneous involution is possible. Operation at any period of life is only demanded when the growth takes on rapid development; under other circumstances, it may safely be left untreated.

LYMPHANGEIOMA.

The lymphatics may also undergo enlargement and new growth within the tissues of the skin, and may form multiple tumors of small size, projecting above the surface in the form of oval or semi-globular, flattened papules and tubercles. They are of a dull-red color, smooth and firm, and look, according to Kaposi, who first described this affection, like a papular syphiloderm. The disease in his case appeared in childhood and continued through life. The structure consists of canals and openings, which are enormously enlarged lymphatics. Much larger lymph tumors of cavernous structures may be formed in the subcutaneous tissues and glands, whence they project themselves into the skin.

RHINOSCLEROMA.

This is a very dense cellular new growth, situated in the region of the nose. It consists of flattened or prominent tubercles of very dense structure, smooth, of a dark brownish-red, or of the color of the skin, isolated, or forming by confluence a firm, abruptly defined mass. Deep fissures may occur in the infiltrated integument, allowing the discharge of a viscid fluid and the formation of crusts. The surrounding skin is perfectly healthy. The seat of the growth is the *ala nasi*, the septum, or the upper lip just at the edge or within the nostrils, from which points it spreads inwards and outwards, causing much deformity in the shape of the nose and lip. The nostrils, which are greatly narrowed, seem carved out of ivory, and the tip of the nose seems to be converted into a thickened plate of cartilage. The progress of the disease is slow, requiring years for its fullest development. Finally, the mucous membrane of the lip becomes involved, and the nasal openings become entirely impervious, so that the patient is obliged to breathe with open mouth. The cartilage and bone even may become affected. Meanwhile, the tubercles undergo no further change, such as softening, ulceration, or carcinomatous transformation, even after many years' existence. The cause of this strange and rare affection is unknown. It affects both sexes and persons in middle life. On cutting into the tubercles, they are found to consist in their early stages of normal connective tissue crammed with small round cells, especially in the upper layers of the corium. Later, the cell infiltration extends to the deeper structures, forcing apart the fibrous framework, and penetrating even the cartilage. According to Kaposi, who first described and has especially studied the disease, the growth is closely allied to the small celled or granulation sarcoma. Other observers, however, regard it as a chronic inflammatory process. Left to itself, the disease progresses slowly and indefinitely, but produces no more serious results than great deformity of the nasal region, and impeded respiration. It is incapable of spontaneous involution, nor can its disappearance be effected except by its destruction, which may be accomplished either by caustics or by excision.

TREATMENT.—The nostrils may be opened up by boring through the masses of new growth which obstruct them with a stick of nitrate of silver or caustic potassa. The pain and hemorrhage are very slight, and no inflammation follows the use of these agents. Such destruction, however, is always temporary. After some months, the nodules begin to grow again from their base, and gradually attain their former size. The growths which affect the outer parts, or which are embedded in the integument, may be excised, and a plastic operation performed at the same time; but even after such radical operations the disease may recur.

LUPUS ERYTHEMATOSUS.

This is a chronic inflammatory process, characterized by the formation of slowly spreading patches of redness, with an elevated margin and flattened centre, the surface being generally scaly, and often terminating in superficial scar formation. The disease begins with the appearance of one or more small points, which are red and somewhat elevated, and which slowly increase in size. After a time the centre of the patch sinks to the level of, or slightly below, the surface of the surrounding skin, while the disease progresses peripherally. Thus, after it has attained or exceeded the size of a dime, it

presents a smooth and shining, or scaly, depressed, central portion, separated from the surrounding healthy integument by an annular, elevated border, occupied by the distended or plugged openings of sebaceous glands. This disease may progress thus for many months or years from a single centre, and may cover large areas of skin; or several patches may coalesce and form a variety of shapes, all sharply defined by the serpiginous border. Its seat is chiefly the central parts of the face, especially the nose and adjoining portions of the cheeks, but it may affect the outlying parts as well, the lips, ears, scalp, fingers and toes, etc. Upon the scalp, it produces bald patches, which are red and shining, and circumscribed by a narrow, elevated border, covered with scales. The course of the disease is generally very slow, a single patch requiring generally several years to reach its maximum development, and terminating, it may be spontaneously, in a flattening down of its border, and the permanent establishment of a thin, superficial scar. The successive development of such areas of disease may prolong the course of the affection over many years.

Prof. Kaposi has described also an acute, disseminated variety of this disease, which may simultaneously affect a large portion of the body, and may be accompanied by grave symptoms, such as painful subcutaneous nodules and swelling of glands, œdematous enlargements of the joints, and deep-seated pains in the bones, with recurrent, erysipelatous and typhoidal forms of fever, which may prove fatal. Such cases are very rare. Commonly, the disease may exist for years confined to a single locality, without complications and without any effect upon the general condition of the patient, its only serious results being the deformity to which it gives rise.

The *anatomical changes* of Lupus erythematosus may show themselves first in any portion of the cutaneous tissues—in the upper layers of the corium and about the sebaceous glands, or in the deeper portions about the sweat-glands—and may extend to all the structures of the skin. These changes consist in collections of small round cells, with the ordinary manifestations of an inflammatory process; swelling of the bloodvessels; serous exudation, distending the connective-tissue spaces and the papillæ; and cell proliferation, producing thickening and redness of the skin, and seborrhœa. The process of involution is characterized by fatty degeneration of the cell elements, by atrophy of the vessels and the glandular structures, and by shrinking of the connective tissue; in other words, by the formation of cicatricial tissue. Very little is known of the *etiology* of the disease. It generally affects persons in middle life, and is very rare in childhood. It is more common in women than in men. It is sometimes a sequel of Seborrhœa congestiva.

TREATMENT.—Lupus erythematosus is a most unmanageable affection. Internally, those remedies only are of service which may be demanded by the general condition of the patient at the time. By far the most serviceable is cod-liver oil, if given for long periods. Externally, the severer forms of caustics, such as are demanded in Lupus vulgaris, are not called for. Among the most valuable applications are the strong alkalis, German soap and its solutions, carbolic acid, acetic acid, sulphur, tar, iodine, mercurial plaster, and chrysophanic and pyrogallie acids. All of these will work effectually, even rapidly, at times, and again, at other times, they will all fail in any measure to control the disease. It is often necessary, therefore, to try many remedies in a single case. Perhaps the most valuable of those above named, are the following:—

Soaps, used alone or in connection with the others. They should be rubbed thoroughly into the affected parts, on a bit of flannel rag, and should be subsequently rubbed to a lather with water, and washed off. The excoriations

thus produced should be then healed by the use of soothing ointments, when the process may be repeated.

Iodine, in solution in glycerine with iodide of potassium (equal parts), painted over the affected regions with a brush, as freely and often as the resulting pain and inflammation will permit.

Emplastrum mercuriale, spread upon linen and worn for twenty-four hours over the affected parts, and reapplied as often as the skin will allow.

Pyrogallie acid, 3j-ij to lard 3j, spread upon cloth and worn for three days and nights, the plasters being renewed twice a day. When the freely suppurating surfaces which are thus produced have healed, the acid may again be used until healthy tissue is obtained.

Scarification and the *curette* have been recommended as efficacious in some cases. Often, with all these remedies at our disposal, and after their repeated trial, in turn, the disease resists our attacks, and may continue indefinitely in spite of them.

LUPUS VULGARIS.

Lupus vulgaris, or simply Lupus, is a chronic destructive affection of the skin and the neighboring portions of the mucous membrane, characterized by the presence of nodular masses, which are embedded in the structure of those parts, and which soften, ulcerate, and leave scar tissue behind them. The process begins with the development of minute tubercles, of a brownish or dull red color, which occur at different depths below the surface, either singly or in groups, and which give the skin a spotted or dotted appearance. This, the primary form of efflorescence, very slowly increases in size, until it attains that of a small shot or large pea, and approaches the surface, causing an elevation and thinning of the epidermis above it. It is then to be felt as an elastic nodule, more or less deeply seated in the skin, and projecting above it. This is *Lupus prominens* or *Lupus tuberculosus*. Several contiguous nodules may continue to increase in size, blend with one another, and thus form much larger elevations of the same dull-red color and elastic feel, and of the size of a large pea or bullet (*Lupus nodosus*, *Lupus tumidus*). Having reached this, their highest stage of development, the nodules may remain unchanged for weeks or months, but sooner or later undergo involution. This is effected in two ways: (1) The tubercle becomes less tense at its centre, or tip, and sinks down, while the smooth and shining epidermis is converted into yellowish-white, or darker colored scales—*Lupus exfoliatus*. The depression or softening (fatty degeneration) takes place very slowly, until, after weeks or months, the tubercle sinks below the level of the skin, the scales disappear, and finally a glistening flattened scar remains to mark the seat of the primary tubercle. (2) By the other process, the softening of the nodule takes place throughout its mass, or suppuration ensues; the protecting epidermis with its scales and crusts is cast off, and a free ulcerating surface is established—*Lupus exulcerans*. Such ulcers are generally round, with slightly elevated margins, and a red vascular base. They crust over readily with the purulent and other secretions of the part, and are capable of healing by healthy granulations and scar formation. Occasionally, the granulations are exuberant, forming papillary elevations, which may terminate in permanent, wart-like excrescences—*Lupus hypertrophicus*, *Lupus verrucosus*. These two processes, exfoliation and ulceration, may affect the same tubercles at various times, or may involve different parts of one tubercle at the same time. In all cases of long standing, we have every stage of evolution and involution going on simultaneously, so that the whole process may be studied at once. Thus, by the constant development of new nodules by the side of the earlier efflores-

cence, the disease spreads outwards, and slowly invades new areas of healthy skin, until by growth from a single centre, or by confluence of contiguous patches, large districts become affected. It may spread in this way with a broad line of advance, forming variously shaped patches of large extent—*Lupus serpiginosus*.

Upon the mucous membrane, the characteristic nodular development of lupus is by no means as conspicuous or as easily recognized as upon the skin. It presents, however, brownish-red prominences, covered with gray epithelium, or excoriated points which bleed easily. These increase in size, or coalesce, until they form large patches, with an uneven surface which is covered with pale epithelium, or which is fissured, or in open ulceration. In the process of involution, the prominences and thickening subside, and a cicatricial sinking of the tissues succeeds. In some cases infiltration of the submucous structures, with suppuration and abscess formation, takes place. From the skin and mucous membrane, the disease may penetrate to deeper tissues, such as cartilage, tendons, etc. It is doubtful if it affects the periosteum or bones.

Lupus presents a variety of clinical appearances according to its localization. Its most common seat is upon the nose and cheeks. Upon the *nose*, it begins generally in the *alæ*, and spreads upwards so as possibly to cover the whole organ, producing, in addition to its characteristic tubercles, a considerable degree of swelling and deformity from the thick crust formation which accompanies it. After a time, the *alæ* are frequently destroyed, either by ulceration, or by atrophy and shrinking through cicatrization. The disease may extend within the nasal openings, from without, or may develop primarily upon the mucous membrane there, where it may exist for years, forming crusts which constantly renew themselves, and which terminate with perforation or destruction of the septum. From the nose, the disease may spread to the *forehead* and *cheeks*, whence, in its serpiginous form, it may extend to the *jaws*, the sides of the *neck*, and the *ears*. It often appears primarily upon the cheek, and may remain for years as a discrete patch, from half an inch to several inches in diameter. Lupus produces great deformity about the borders of the eyelids, mouth, and ears, often destroying large portions of the latter, and occasionally spreading inwards to the tympanum, and producing perforation. About the *eyes*, it may cause ectropion by final cicatrization, or may attack the conjunctiva and cornea. From the *lips*, it may extend inwards to the *gums*, *soft palate*, and *trachea*, producing destructive ulceration of their tissues, with hoarseness, chondritis, stenosis, etc. Upon the *extremities*, lupus exhibits some of its gravest lesions and sequelæ. Generally of the serpiginous form, in addition to the extensive ravages upon the skin itself, in consequence of repeated attacks of deep-seated inflammation of the tissues about the feet and hands—in the form of lymphangitis, periostitis, caries, and necrosis—great deformity of the small bones of these parts is produced, the fingers and toes being greatly thickened, widely separated, curved, permanently contracted, and the like. Tegumentary changes, similar to those described under Elephantiasis Arabum, may also in time affect the lower extremities, with disease of the bones and papillomatous outgrowths. In the midst of all these most varied, abnormal tissue-changes, the true lupus process goes on with its primary tubercle and final scar formation, making in all a most complex presentation of disease. To this list of pathological concomitants and sequelæ of the affection in general, erysipelas must be added, with at times adenitis—when the disease is seated in the neighborhood of small glands—and, rarely, carcinoma.

ETIOLOGY OF LUPUS VULGARIS.—Lupus begins almost always in childhood, rarely after puberty. It affects both sexes in nearly equal proportions, but

the female sex rather more frequently than the male. In America it is by no means a common disease, although the mistake is often made of calling any destructive disease upon the face lupus. Its relations to scrofulosis or struma are problematical. With syphilis it has no demonstrable connection. It is neither contagious nor hereditary.

PROGNOSIS.—The course of lupus is always chronic. Beginning in early childhood, it may continue for years confined to a single small patch, or disseminated widely over the surface. It may cease to be active after long or short duration, and after many years, even in old age, may revive. Its effect upon the general system, even when of extensive distribution and long continuance, is very slight. It is capable of local cure in its simpler manifestations, but relapses cannot be prevented.

MORBID ANATOMY.—According to Kaposi, whose studies of its tissue changes are the most recent and elaborate, lupus presents in its early stages globular accumulations of small cells, situated between the bundles of fibrous tissue of the corium, beneath the vascular layer; thence the cells follow along the course of the vessels into the papillæ, around the glandular systems, and gradually diffuse themselves throughout the whole structure of the corium. At a later period, the sebaceous and hair follicles undergo atrophy, and perish, and, in the process of involution, the lupus cells themselves undergo fatty degeneration. In the subsequent stages of exfoliation, ulceration, cicatrization, new growth of connective tissue, etc., the anatomical changes are the same as those which characterize similar processes in other diseases.

TREATMENT.—There is no specific internal remedy for lupus, no drug which will cause the characteristic tubercle to disappear, or prevent the recurrence of the disease. When, however, the general system is reduced, or when anæmia or functional disturbances are present, much may often be accomplished, by the administration of medicines, in bringing the tissues into a condition to respond more readily to local measures. The most valuable of these medicines are iron, cod-liver oil, and iodide of potassium. They may be used as long as the patient seems to need their general action upon the economy. The objects to be accomplished by local treatment are the direct destruction of the lupus growth, and the restoration of the skin, as far as possible, to its normal condition. The first object may be accomplished by the use of so-called caustics or mechanical means. Of the former, a great number have been employed, but among them all there is none so serviceable, on the whole, as the stick of nitrate of silver, as it is in itself a tool which may be made to penetrate to the deepest parts of the disease, and as its action, while sufficiently destructive, is never excessive. A stout stick of the pure salt, well sharpened by boring into a wet sponge, or the prepared crayon hardened by a mixture of chloride of silver, is to be fitted into a handle, and then bored firmly into the nodules, whether prominent or bedded deeply in the integument. They are easily penetrated by the sharp point, giving the impression of boggy tissue to the operator. The skin is to be thoroughly ploughed up in this way, wherever the stick is allowed admission. The experienced hand soon learns to distinguish the resistance offered by the normal tissues.

When the disease is in the stage of exfoliation or in that of ulceration, the scales and crust are to be roughly torn away by the stick, and the surface or underlying softened parts thoroughly bored into. The bleeding may be always readily checked with absorbing cotton, or lint, and a little pressure. This operation is painful, but patients will ordinarily endure it, if the disease

be not very extensive, without etherization. The pain may be mitigated in some measure by first freezing the part. It is not of long duration. The parts cover themselves immediately with blackened bloody crusts, which are to be torn off with the crayon at the next burning, which should ordinarily follow in a few days. The process is to be repeated until all diseased tissue has been destroyed, as shown by the impossibility of forcing the point into the tissues. The scars which follow this method are generally smooth and well formed. Chloride of zinc is used, either in solution, or mixed with starch in the form of a paste (Canquoin's), or with chloride of bromine and chloride of antimony (Landolfi's), but it works upon sound and diseased tissues alike, and has no advantage over nitrate of silver. A favorite preparation in the hands of Professor Hebra, is an arsenical paste (white arsenic, one part; artificial cinnabar, three parts; emollient ointment, twenty-four parts), spread thickly upon linen and applied to the affected region. It is to be renewed once in twenty-four hours, and worn constantly for from two to four days; on the third day it becomes very painful. The advantages of this method are that by it only the diseased tissues are destroyed, the healthy and cicatrized parts being left intact. In no case has Prof. Hebra seen poisoning produced by its use, but he has never applied it to a patch larger than the hand. Vienna paste, and other preparations of caustic potassa, destroy healthy and diseased structures alike. Pyrogallic acid and lard, one part to eight—spread upon linen and worn several days—is often effective in superficial forms of the disease. The galvano-cautery and Paquelin's cautery are both of great service for the destruction of the nodules in their early stage, as well as for application to large ulcerations and outgrowths. These and all destructive agents are to be used repeatedly, until the morbid growths are exterminated and fail to reappear. The mechanical methods of frequent scarification, or multiple punctures with the lancet or bistoury, and the scraping or gouging process with the curette, are of service, especially the latter, although it is frequently necessary to apply caustics after using the spoon. Whichever of the above methods be chosen, it must be used vigorously, *without mercy*, it might be said. Most cases require protracted treatment, and often one after another of all the means at our disposal is called into action, sometimes seemingly in vain. In case of relapses we must begin over again.

LEPROSY.

(Synonyms: *Lepra*; *Elephantiasis Græcorum*; *Spedalskhed*; *Der Aussatz*.)

Leprosy is a chronic disease of the general system, showing itself in the form of various changes in the integument and other structures of the body, and terminating fatally after some years. It still prevails as an endemic evil of enormous extent in some countries—Norway, India, China, the Sandwich Islands, etc.—but is distributed also in a less degree over nearly all regions of the globe. In North America, it occurs in Mexico and the States south of it; in Louisiana, South Carolina, and Minnesota; and in New Brunswick. Sporadic cases have been observed in many parts of the United States. After prodromal symptoms of months' or years' duration, consisting of debility, irregular action of the digestive system, and, in some persons, an occasional outbreak of bullæ resembling pemphigus, the disease manifests itself upon the skin in three well marked varieties or types, called the tubercular, macular, and anæsthetic forms.

The first of these, *Lepra tuberosa*, begins with the appearance of red or brownish spots, varying in size from that of a small pea to several inches in diameter, irregular in shape, and situated upon the face, arms, legs, palms, and

soles, singly or in numbers. The skin in such patches is smooth and somewhat thickened. They may remain in this condition for weeks and months, changing somewhat their shape and size, and may partly disappear. After a time, it may be a few years even, some of the spots become more elevated, and elsewhere real tubercles appear, varying in size from that of a small shot to that of a filbert, of a dull or brownish-red color, shining or scaly, elastic and rather soft to the touch, discrete, or forming by confluence large irregularly shaped prominences. They appear in greatest numbers on the face, especially about the forehead and nose, forming above the eyes thickened areas of skin, which overhang them and give so marked a prominence to this region as to cause the face to resemble that of the lion (*Leontiasis*). The nose, too, becomes uneven, and broadens, and the lips are greatly thickened, so that altogether great facial deformity results. The tubercles appear also upon the mucous membranes of the nose, buccal cavity, and trachea. They affect, too, the conjunctiva and cornea. Upon the trunk and limbs, they show themselves scattered and grouped as prominences and embedded nodular masses. Everywhere they exhibit a sluggish course. Some, after months, are reabsorbed, leaving dark pigment stains; others undergo degeneration and soften, forming indolent, shallow ulcers, which last indefinitely. Over the joints especially of the lower extremities, the destructive process penetrates more deeply, and is accompanied by inflammation of the lymphatics, suppuration of joints, and loss of members, such as the fingers and toes—*Lepra mutilans*. After a time, and before such grave structural changes have taken place, the general condition of the patient shows serious involvement of the internal organs. Frequent exacerbations of fever come on, and diarrhœa, inflammation of the lungs, or cerebral symptoms develop, and either prove fatal or subside to renew themselves in subsequent exacerbations. Thus the disease progresses, sometimes with exceptional rapidity, terminating by death in two or three years, but generally protracted through a period of alternate activity and inactivity, of nine or ten years.

Lepra maculosa, the macular variety of the disease, appears in the form of the spots above mentioned, of a reddish-brown color, or of a yellowish-white aspect, circular or streaked in shape, and with or without infiltration. The red or brown spots (*Morphæa rubra* and *Morphæa nigra* of authors) may gradually become pale in the centre, and finally wholly white (*Morphæa alba*), or the integument may atrophy (*Morphæa atrophica*), or the spots may assume a hard, bacon-like form of infiltration (*Morphæa lardacea*), and subsequently undergo atrophy. The spots more frequently occur upon parts protected by the clothing. *Lepra maculosa* may pass into the form just described, *Lepra tuberosa*, or, by assuming its peculiar nervous phenomena, into the third variety, which is *Lepra anæsthetica*. This is characterized by the occurrence of anæsthetic patches of skin, which may develop upon the macular or tubercular efflorescence of the preceding varieties, or upon the seats of bullæ which form a conspicuous prodromal feature in this form of leprosy for months or even years, or which may appear upon portions of the integument previously and otherwise normal. The anæsthesia is at times so complete that a needle may be run into such patches to a considerable extent without the knowledge of the patient. This loss of sensibility is often preceded for a long time by congestion and hyperæsthesia of the parts, and both this excess and loss of nervous susceptibility may frequently shift their position. When the anæsthesia becomes permanent, such spots may become deeply pigmented and atrophied. This atrophy extends to the muscular tissues also, giving rise to changes in the expression of the countenance, and inability to close the eyelids and mouth. The trunks of the brachial nerves are to be felt as swollen and painful cords, and the fingers remain in a semi-flexed condition. The

hairs fall from the scalp and face; the nails and skin become dry; the epidermis is cast off, leaving indolent ulcers; the joints become necrosed, and drop off; or moist and dry gangrene of the feet and hands may cause the loss of whole members (*Lepra mutilans*). In these advanced stages, the general system suffers in serious ways: debility, diarrhœa, reduced heart's action and dementia come on, and the patient finally dies of marasmus, tetanus, pyæmia, or pneumonia, or with typhoidal symptoms, etc. This, the last stage of the anæsthetic form, is generally the termination also of the two other varieties.

ANATOMY OF LEPROSY.—The microscopical appearances of a tubercle in leprosy closely resemble those of lupus growth—that is, small-cell granulation tissue—excepting that it is not so confined to isolated masses as in the early stages, but is diffused throughout the corium, especially along the course of the vessels and about the glandular systems. Subsequently this tissue undergoes degeneration, as in lupus, with the formation of large colloid corpuscles. The nervous structures are the seat of marked changes, the result of chronic inflammatory processes, with thickening of the nerves, small-cell deposits in the neurilemma and between the bundles, and, finally, fatty degeneration of the same with atrophy of the nerve fibres. A large part of the nervous system may be thus affected. The internal organs also do not escape, similar changes being found in the testicles, liver, spleen, kidneys, lungs, etc.

ETIOLOGY.—Of the direct causes of leprosy, it may be said that we know nothing, unless we admit its communication by contagion. It occurs in all parts of the world, irrespective of temperature, moisture, altitude, diet, or any recognized physical conditions. It at one time covered Europe with lazarettos. It is on the increase in some regions, and has shown an activity and virulence, during the last twenty years, in the Hawaiian Islands, equal to that displayed at the time of its most extensive ravages in the middle ages in the eastern hemisphere. We know only one fact certainly: that it is hereditary; that a certain proportion of a leper's children are liable to the disease in after life; but that this development is retarded in the descendants, and that the character of the affection is perhaps mitigated by residence in non-leprous regions. On the other hand, there can be no doubt that in individuals without such hereditary taint, the disease is much more liable to develop in regions where leprosy abounds—that is, where lepers live—than in other localities. This suggests the possibility of contagion by direct or indirect personal contact. Certainly, a study of the spread of the disease in the Sandwich Islands, a virgin soil for such an investigation, warrants a revision of the commonly accepted, modern, professional dictum that it is not contagious. Very strong data exist to prove that the disease has been communicated there, at least, by contact, and such is the firm belief of all physicians who have observed it in those islands. It might well be inoculated by means of vaccination, or in connection with venereal lesions, from leprous subjects. It may first show itself in early childhood, or at any subsequent age.

PROGNOSIS.—The disease is almost uniformly fatal, although its course may be influenced, favorably or unfavorably, by the circumstances and residence of the patient. Removal, in the early stages of the disease, to regions where it is not endemic, may delay its progress. In this connection it may be mentioned that Dr. Gronvold, of the Norwegian Colony in Minnesota, has furnished to the American Dermatological Association interesting data regarding the disease as it exists among his countrymen, showing an equal representation of the tubercular and anæsthetic forms; its steady progress in those patients who exhibited the first symptoms of the malady in the old world; and no

instance in which the disease has been transmitted to children born in America. He believes that the disease in his patients would have advanced more rapidly in the old world. In a very few, the disease seems to have remained without increasing in severity, but in the larger number it has been in no way retarded. The tubercular form of leprosy proves fatal, on an average, in nine years; the anæsthetic form in eighteen years; cases may continue for twenty-four years.

TREATMENT.—There is no specific remedy for the cure of leprosy. New drugs have been from time to time introduced into its therapy, their fleeting reputation having been based upon their temporary, tonic action; among the most recent of these are Gurjun balsam and Chaulmoogra oil. The patient should be removed if possible from leprous regions, and the individual symptoms met at once, as far as practicable, with proper remedies. The strength is to be sustained with nourishing food, good air, and tonics. The cutaneous manifestations may be influenced somewhat by treatment. The tubercles and infiltrations may be painted with iodine preparations, or covered with mercurial plaster, by which their absorption is promoted. Ulcers are to be handled according to general surgical rules. Anæsthesia may be relieved to some extent by electricity. The dangerous intercurrent affections, and the final marasmus, of course demand their own appropriate treatment.

PERFORATING ULCER OF THE FOOT.

(Synonym: *Mal perforant du pied*.)

The individuality of this peculiar affection was first pointed out by Nélaton, in 1852, but its true nature has been recognized only within a few years. It is not strictly an *ulcer*; it is an *opening* upon the surface of the foot, communicating by a sinus with the interior disease, which opening may be surrounded by granulations, may be seated in the centre of a corn, or may be established in portions of the integument only slightly inflamed; it may, however, be surrounded by extensive ulceration of the cutaneous tissues. The situation of the orifice is, most commonly, over the articulation of the metatarsal bone with the phalanx of the great or little toe. It may, however, be on other parts of the foot, or upon several parts at the same time. Both feet may be affected by the disease, and in rare instances it occurs upon the hand. There is generally but a slight discharge of a sanious fluid, from the opening, and, if this be probed, the instrument passes directly through a narrow sinus to diseased bone. There is no pain in the part, but, on the contrary, a marked insensibility of the opening or ulcer, an anæsthesia which extends to the surrounding portions of skin in an irregular way. The toes especially are insensible. The temperature of these parts is generally reduced, and their surface is often covered with perspiration; otherwise, the skin in the early stages of the disease presents no abnormal appearance, and motion of the limb is not interfered with. At a later period, for the disease progresses very slowly, the tendons become affected by the internal changes, causing distortion of the toes. The nails are yellow and fissured, and assume a lateral curvature. Thick collections of epidermis form upon the soles and dorsum of the foot, and the cutaneous pigment undergoes hypertrophy. The hairs, too, of the part take on undue growth. An examination of the foot shows extensive changes of the internal structures, sinuses running from the ulcers or orifices to carious bones, with inflamed bursæ, open joints, and the disappearance of cartilages.

The nature of this disease, which affects men especially, but sometimes

children, has recently been satisfactorily explained by a study of the nerve-tissues of the affected parts. The endoneurium of the nerves leading to the seat of disease has in all cases been found to be thickened, while their sensory and nutrient fibrils have been found wanting or degenerated. The larger or motor fibrils are unaffected. In consequence of these changes, the nutrition of the parts is destroyed, and the tissues supplied by them undergo degeneration. The disease may, therefore, begin within, as well as upon the surface. Similar ulceration of these structures has in fact been observed in consequence of diseases of the nerve-tissues, in anæsthetic leprosy, locomotor ataxia, and progressive muscular atrophy, and in cases of compression of nerve trunks and of the spinal cord. Injuries of the peripheral nerves may in this way account for the occurrence of perforating ulcer after contusions of the feet, as has often been observed. We must regard the affection, therefore, as primarily one of the nervous tissues, either of central or of peripheral origin, and all other changes of structure as secondary to, and dependent upon, disturbed nerve action. This explains the frequent and persistent recurrence of the disease in its cutaneous manifestations, after these have been healed by prolonged rest of the parts, and its repeated return after excision of all the apparently diseased structures. The prognosis is therefore doubtful, as there can be no certainty of a permanent cure.

TREATMENT.—By prolonged rest of the limb in a horizontal position, the ulcer or orifice in the integument may often be made to heal, in the early stage of the affection, only to establish itself again, however, in most cases, when the part is used. Excision of the soft parts, or amputation of the toes, or of even more extensive portions of the foot, has often been followed by equal want of success. It is apparent that, to be radical, such an operation should include also the whole of the diseased nerve tissue, that is all the parts which are anæsthetic. As a palliative method, it has been suggested that the patient should wear an artificial leg attached to the bent knee, so as to constantly relieve the foot from all pressure or jar.

CARCINOMA.

Under this general term may be included all forms of cancer of the skin; that is, new growths of the cutaneous tissues which have a malignant course, and which are characterized by collections of proliferating epithelial cells, arranged in alveolar form, or in tubular, bulbous, or dendritic shapes, within meshes of fibrous tissue. These forms are *epithelioma*, *connective-tissue cancer*, and *melanotic cancer*.

EPITHELIOMA. (Synonyms: *Cancroid*; *Epithelial cancer*; *Rodent ulcer*.)—Epithelioma presents three quite distinct clinical varieties: the flat or superficial form; the deep-seated or nodular form; and the papillomatous form.

Superficial Epithelioma.—This form of the disease is better known as *Rodent ulcer*. It begins as a minute, firm, yellowish or red prominence, or as a group of such prominences arranged in a line or cluster, which may exist in this inconspicuous form for a considerable period. Sooner or later, the growth becomes slightly scaly on its summit, and subsequently softens at its tip, and is excoriated, giving escape to a little fluid, which dries upon it into a yellowish or brownish crust. The scale is frequently removed intentionally, or by accident, only to form again, becoming thicker each time, while the nodules very gradually increase in size. It may continue in this condition for years, scarcely

attracting the attention of the patient, who regards it as an innocent pimple, or, perhaps correctly, as a wart or mole which has existed beyond the period of his recollection, as this form of the disease very often has its seat and starting-point in such pre-existing, harmless growths. After a time, however—it may be five, ten, or more years—the disease assumes a more active course. New nodules, resembling the original formation, appear at its edge: minute globular elevations, containing a soft material resembling milia, which may be squeezed out, and are found to consist of masses of epithelial cells. These in turn desquamate, become excoriated, and add to the size of the original crusted lesion. Thus, in time, a circular prominent patch, of a dull-red color and covered with scales and crusts, is formed, varying in size from that of a pea to that of a dime, when eventually the whole central portion softens and is cast off, leaving a shallow, ulcerated surface. Its shape is generally irregularly circular, and it is separated from the surrounding skin by a slightly elevated, hard border, which often overlies a deep infiltration. The surface of the ulcer is generally flat, and of a dull-red color, secreting a thin, viscid fluid, which dries into a firm crust.

In this way the rodent ulcer is established. Its growth may continue by the same process of development of fresh nodules at its periphery, until it becomes one or more inches in diameter, characterized, however, to whatever size it attains, by the elevated, sharply-defined, infiltrated border. At any time the ulcer may show a disposition to spontaneous involution, the epithelial new-growth being cast off by suppuration, or otherwise perishing at its base, and a thin, depressed cicatrix forming in its place. The scar formation may be only partial, however, the ulcer healing in the centre while it progresses peripherally, or undergoing a complete cure throughout its extent, with the exception of some portion of its border, which still remains indurated. Until this infiltrated edge is wholly resolved, the activity of the disease at such parts is to be counted upon. Even when the cicatrization seems to be universally complete, it may revive at any point of its periphery. In this way the disease may go on in alternate stages of progress, partial cicatrization, quiescence, and renewed activity for many years, until considerable portions of the skin have been run over in its spread from the original centre, the patient remaining in good health, and the nearest glands being unaffected. At times, more or less pigment is deposited in the border, or scar tissue, especially when the disease affects the serotum (*soot cancer*). Except for the disfigurement which it causes, the prognosis of rodent ulcer may be regarded as not unfavorable, unless it should become the seat of the deep form of epithelioma, into which it may at any stage be transformed.

Deep-Seated Epithelioma.—This, the nodular form, may, as above stated, be developed from the flat variety, or rodent ulcer, at any period of its existence, or may start primarily in the normal skin. It begins as a firm nodule, as large as a shot or pea, single or multiple, which is felt from the start to include the whole extent of the cutis, and to penetrate at times the subcutaneous tissues. Its growth is generally very slow, attaining after months, it may be years, the size of a filbert, or perhaps exceeding it, and forming a firm, shining, reddish tumor of a flattened or globular shape, which is at first movable with the skin, but subsequently becomes adherent to the underlying tissues. It may spread peripherally, and affect a considerable portion of the skin, showing itself superficially by an uneven surface, or nodular elevations, or by central depressions produced by the shrinking of the older diseased tissue, and peripherally by a smooth, notched, or abruptly elevated border. Occasionally, the small canceroid nodules above described show themselves at the edge of the growth. After a time, it may be months, but in other cases

several years, the growth undergoes ulceration, superficial or deep seated, according to the depth to which the cancerous infiltration has penetrated. In the former variety, we have an ulcer similar for a time to that of flat epithelioma; in the latter, one extending by gradual penetration, or by rapid disintegration of the upper layers of the skin, to deeper parts. It presents a finely granular, reddish surface, which secretes an ichorous fluid, forming, it may be, a thin glaze over it, and has an abrupt, hard, irregular edge. The ulceration follows closely upon the spread of the infiltration peripherally, so that it constantly increases in extent and depth. It does not confine its ravages to the cutaneous tissues, but penetrates to all underlying structures, muscle, cartilage, and bone. Occasionally a portion of the growth may slough away, and leave healthy granulating tissue, which tends to cicatrization, but such attempts at spontaneous cure are partial, and do not affect the final result. Sometimes, too, the growth assumes the appearance of medullary cancer in late stages. The glands eventually become implicated, sharp pains in the part reduce the strength of the patient, marasmus gradually develops, and, after years of such progress, a fatal result ensues.

Papillomatous Epithelioma.—Sometimes epithelioma begins in the form of an elevated growth—having at times a constricted neck, at others a broad base—varying in size from that of a dime to a diameter of several inches. Its surface is flat, or umbilicated, smooth, or covered with yellowish, closely adherent scales. In its advanced stages, its surface is ulcerated and granulated, or fissured, red, bleeding easily, and discharging an ichorous fluid which covers the growth on drying with brownish crusts. The same comedo-like, nodular masses may sometimes be squeezed out from it as from the two preceding varieties. It may develop in the course of the flat epithelioma, in which case its seat is superficial; or from the nodular form, when it may be felt extending deeply into the cutaneous tissues. It may originate in its own form, but more commonly grows from surfaces already affected by one of the other varieties, and runs a more or less rapid and malignant course according to the particular form with which it is associated.

Locality of Epithelioma.—The most common seat of epithelioma is on the face or genitals. It seldom occurs primarily elsewhere. Upon the *face*, flat epithelioma most frequently affects the region of the nose, eyelids, and cheeks, from which it may spread extensively to neighboring parts of the integument. It is in these regions that warts and senile forms of keratosis are so apt, in late life, to become the starting-point of the disease. Disfigurement, even in the course of the superficial form, is often produced by shrinking and cicatrization in the regions of the nose and eyelids, but when the disease assumes the nodular form, the destruction and disfigurement are often frightful. The eyelids may be wholly destroyed, the soft parts of the nose eaten away, or the ear entirely consumed. From these openings, the disease penetrates to the mucous membrane and soft parts of the adjoining cavities, finally attacking the bones. The teeth are lost, the antrum and frontal sinuses are opened, and the surface of the cranium may be exposed and destroyed by necrosis, so that the membranes of the brain become visible. The fungoid or papillomatous form may develop in such advanced stages of the disease. Upon the lip, epithelioma begins almost always in the nodular form, and may spread to the mucous membrane of the mouth. At times, all three varieties of the affection may be exhibited simultaneously upon the face, in these various regions. Upon the integument of the *genitals*, the disease may begin in the flat form, which, with little delay, becomes deeply infiltrated, and runs a comparatively rapid, fatal course; or it may slowly spread without infiltra-

tion upwards over the pubic region, or down upon the inner thighs in a serpiginous course. Upon the *trunk*, epithelial cancer very rarely occurs primarily; upon the *extremities* still less often, unless it be developed upon preceding lupus growths, or ulcers from other forms of disease.

Anatomy of Epithelioma.—According to Kaposi, who has given an admirable account¹ of the new growths of the skin, a section of its structure in the *superficial* form of epithelioma, shows that the prolongations of the rete downwards into the corium are greatly elongated in the form of slender conical cylinders, which broaden as the disease progresses, and nearly obliterate the intervening papillæ, or even send out lateral processes, which anastomose with similar processes, or which terminate in free bulbs. In the *nodular* or *deep-seated* form, these epithelial, cylindrical new growths penetrate more deeply into the fibrous structure of the corium, interlacing in all directions, and, in addition to them, globular masses, having an alveolar or concentric arrangement, are found, consisting of small cells in their central portions, and of large flattened cells in their external layers. These peculiar bodies are called *globes épidermiques*, *epithelioid pearls*, *epithelial globes*, *inflammation cells*, etc. They occur in the midst of the epithelial cylinders, of various sizes, but they are not peculiar to epithelioma. The *connective tissue* is not materially altered in the flat form of the disease, but in the deep seated variety is not only encroached upon, throughout, by the new growth of the epithelial bodies, but these are surrounded by round cells, and, in the papillomatous form, traversed by new bloodvessels. The *glandular structures* of the skin are but slightly altered and enlarged, or undergo fatty or colloid degeneration. In the progress of the disease, the encroaching cylinders destroy the corium and underlying tissues by atrophy or by interrupting their nutrition. The new growth itself may undergo fatty or colloid degeneration, become absorbed, or break down in ulceration. The epithelial new growth has its origin, according to Virchow, in the connective tissue; according to Thiersch, only from the pre-existing epithelium of the rete or glands; according to Koester, from the lymph cells; according to Biesiadecki and Warren, from the small wandering cells or leucocytes. Kaposi's own views are that the first canceroid cylinders are the epithelial cones of the rete, proliferating freely; that the epithelial lining of the sweat-glands may also serve as the starting-point of the proliferation; and that it is probable that the connective tissue involved may be stimulated to epithelioid as well as to inflammatory proliferation.

Etiology.—Epithelial cancer, although much more common after middle life, is not impossible in childhood. It occurs more frequently in men than in women. There is no evidence of a tendency to its being inherited. Excepting the action of local conditions, we have little knowledge of its causes. Any chronic alteration in the epithelial structures of the skin may conduce to its development, and accordingly warts, pigmented or sebaceous, collections of epidermal scales, the bases of cutaneous horns, etc., frequently serve as the starting-points of the disease. Senile forms of keratosis, especially, are prone to such transformation into epithelioma, and all such conditions of the cuticle should be looked upon, in old people, as possible seats of the affection, and should receive proper treatment in view of such suspicion (page 62). Again, long standing inflammatory states of the cutaneous tissues may become the seat of such transformation, as is seen in old ulcers of the leg, lupus granulations, etc.

¹ Pathologie und Therapie der Hautkrankheiten. Wien, 1881.

Prognosis.—Some of these forms of epithelioma are so little dangerous that they scarcely deserve the title “malignant.” The *superficial* variety may continue to progress, or remain stationary, for fifteen or twenty years, and then heal by cicatrization, permanently or temporarily; or may exhibit, for long periods, only a slight activity, at points about the periphery of the scar. On the other hand, its prognosis is much more serious should it develop into the *nodular* form of the disease. This variety, although capable of protracted quiescence or very slow progress, has always an unfavorable future if left untreated, producing not only deep destruction of tissue, but often loss of life itself. The *papillomatous* or *fungoid* form is still more dangerous. All forms, if treated in good time, are susceptible of complete cure. Epithelioma may recur, after extirpation, but only locally; and in its advanced stages, its progress may generally be stayed, or its fatal end delayed for a long time.

Treatment.—Internal remedies, in epithelioma, are of service in those stages only in which the strength of the patient has begun to fail. There are none which have a specific action upon its course. Extirpation of the cancerous growth is the only resource. This may be effected by cauterization or by excision, and the choice between these methods must be determined in each case by the extent and position of the disease. One is as effectual as the other, where both can be thoroughly applied, and recurrence is, in such cases, equally common after both.

In the *superficial* forms of the disease, caustics are decidedly the best remedy, because their destructive action penetrates to sufficient depth to exterminate the new growth, and produces only a thin scar without subsequent contraction of the surrounding integument—a most important consideration in the vicinity of the eye and nose. When the disease occupies a large area, too, cauterization is the only practicable operation. The special agents to be employed are those which have been recommended in the treatment of lupus, as the same object is to be accomplished in both affections, viz., the destruction of new cell growth. In the flat form, where the infiltration is superficial, this may be effected by the use of the milder caustics, such as pyrogallie acid. This, mixed with lard in the proportion of one or two to eight, and spread thickly upon cotton cloth cut to fit the area to be attacked, is to be applied for three days and nights continuously, fresh plasters being substituted each morning and evening. This process is to be repeated two or three times, if necessary, as soon as the crust which follows the action of the caustic falls off; that is, until healthy cicatrization is established. Should this result fail, we may, as in lupus, resort to the arsenical paste (page 89), spread thickly upon strips of cloth, and applied for three days, the paste being renewed every twenty-four hours. The pain and œdema, especially about the eyes, which come on during the third day in both methods, rapidly subside when the caustics are removed. Under the action of both methods, only the diseased growth is destroyed, the healthy tissues remaining unaffected by the caustic. Single points of growth may be destroyed by thorough boring with the crayon of nitrate of silver, used repeatedly at intervals of a few days. In the *nodular* form of epithelioma, we may use the stick of nitrate of silver, gouging out with it the soft growth, or we may employ the curette, applying the cautery after scraping. Concentrated nitric acid, too, may be used, boring into the growth with a pointed stick of wood dipped in the acid. If the nodules extend very deeply, we may destroy them with Vienna or chloride of zinc paste. The same applications may be employed for the *papillomatous* growth, but they should never be used when it is important to save as much tissue as possible, for they respect neither sound nor diseased structures.

Where the growth is deep, and occupies a small area, excision may be resorted to, as affording a linear scar only, and as being a shorter process than the slow repair which necessarily follows deep canterization. A plastic operation may often prevent or correct marked disfigurement upon the face. Every case should be closely watched after any form of operation, and every nodule should be destroyed with caustic at once, as it appears about the edge of the wound or cicatrix, or, if deep infiltration recur, the whole mass should be extirpated again without delay. In this way, by constant watchfulness and attack, nearly every case may be restored to and kept in a healthy condition, if treatment be begun before the disease has become very extensive. In even the most advanced stages, its progress can be delayed, and the general condition of the patient improved by such local treatment alone.

CONNECTIVE-TISSUE CANCER.—Other forms of cancer affect the integument, either primarily or by extension from underlying parts. One, the so-called *lenticular* variety, is developed in the skin above a mammary cancer, or after its excision, in the form of nodules, which vary in size from that of a pin's head to that of a bean, and are firm and glistening, and sometimes reddish-brown in color. Subsequently the nodules may soften at their summits, and become excoriated, and may unite to form irregular, tubercular masses. In this way, large districts of skin upon the chest may be converted into a tissue of cuirass-like hardness, which may extend down upon the lower trunk or the arms. The glands in the axillæ become enlarged, and a fatal termination is not long delayed. In another form, *Carcinoma tuberosum*, the disease appears, in old persons, as larger nodular swellings, the size at times of a walnut, or hen's egg, occurring upon the face and hands. The swellings may occur in large numbers over the general surface, and are generally associated with similar masses in the internal organs. The surface of the tumors is often of a dark-red color, is easily denuded, when it becomes covered with a greenish crust, or may be destroyed by deep ulceration. In some situations, the surface may assume a warty, fissured condition, especially upon the back of the foot. Single nodules may be completely cured by ulceration. After a few years, the disease generally ends fatally.

MELANOTIC CANCER.—The third variety is *melanotic* or *pigmented cancer*. This begins in the form of one or several, smooth, round nodules, of a slate or black color, of the size of a small shot or pea. They are situated most commonly, at first, upon the hands and fingers, feet and toes, but may begin upon any part. They enlarge, or, by confluence, form an irregular, tubercular, fungoid growth. After a time, the mass softens, and is converted into an ulcer, which penetrates deeply into the underlying tissues. Subsequently, other nodules appear, either about the primary seat or scattered along the course of the large lymphatic vessels, until the legs and abdomen become quite thickly occupied by the small blackish nodules. After death, to which termination the disease generally hastens at a rapid rate, the internal organs are often found abundantly infiltrated with similar melanotic masses. The nodules consist of a coarse, vascular network of stroma, having in places an alveolar arrangement, and containing small and large epithelial and spindle-shaped cells, in the form of nests or irregular collections, and diffused and granular pigment.

For these forms of connective tissue and melanotic cancer, little can be done; and excision of individual, even of the primary, nodules, does not prevent their recurrence, nor check the fatal progress of the disease. The tendency to diarrhœa and marasmus, which marks the later stages of the affection, is to be, as far as possible, anticipated by tonic treatment.

SARCOMA.

A multiple form of this disease shows itself, as described by Kaposi, upon the hands and feet—generally upon the latter first—as firm, round nodules, of a brownish or purplish color, varying in size from that of a small shot to that of a bean. These nodules present themselves in a discreet arrangement, or grouped, and are accompanied by thickening of the integument of the feet and hands, which are painful and impeded in movement. After some months, the oldest nodules become scaly and shrink away, leaving a pigmented depression. The confluent patches likewise undergo atrophy in their central portions, leaving the periphery elevated in the form of a firm, hard, pigmented, scaly wall. They never ulcerate. At a later period, the nodules spread to the arms and legs, and, in the course of two or three years, develop upon the face and trunk, of larger size and darker color. Sometimes they soften superficially, exposing a bloody surface. With the more general diffusion of the disease, fever, diarrhœa, and marasmus occur, and it proves fatal in from three to five years. After death, similar reddish, nodular masses may be found in abundance in the lungs, spleen, heart, and intestinal canal. The nodules consist of small round cells arranged in groups, hemorrhagic deposits, and pigment. In other cases large-celled growths have been observed.

In another form of sarcoma, these cutaneous phenomena are greatly exaggerated. Infiltrated, red patches appear suddenly upon any part of the body, and may afterwards disappear, leaving brown stains, or may increase in size so as to cover considerable areas of skin. Their surface may cast its epidermis, and allow a serous or bloody discharge to escape. On other parts, fungoid tumors may arise, of a red or violet color, varying in size from that of a bullet to that of a hen's egg, sometimes smooth of surface, sometimes fissured. These growths may also disappear spontaneously, or may undergo ulceration. They may occur in great numbers and upon any part of the surface. They, too, consist of masses of small round cells infiltrating the fibrous tissue of the corium and underlying structures. This form of disease has received various names from its respective observers, such as *Mycosis fungoide*; *Inflammatory fungoid neoplasm*; *Fungoid papillomatous tumor*, etc. It ends fatally, generally within two or three years.

MADURA FOOT.

(Synonyms: *Mycetoma*; *Podelkoma*; *Fungus foot of India*.)

This is a destructive disease of the feet, and occasionally of the hands, which is prevalent in certain parts of India. The foot becomes greatly swollen and deformed, and presents numerous tubercular elevations, with fistulous openings from which a peculiar matter is discharged. The affection begins sometimes with the appearance of pimples or sores about the toes, sometimes with congestion and thickening of the integument; we have, however, no very definite account of its earliest manifestations. When first seen, the part generally presents small tubercular elevations, which discharge a thin fluid from fistulous openings. These tubercles gradually multiply; the foot undergoes thickening, losing all shape; the toes are distorted, or blend with the common mass; and the calf dwindles. The progress of the disease is very slow, lasting from five to twelve years. It is accompanied by severe pains in the part. The skin has generally a peculiar whitish appearance about the mouth

of the sinuses, and from them are at times discharged peculiar black and white masses. The same kind of black granular matter sometimes studs the surface of the tubercles, and has, in its gross appearance, been likened to fish-roe. On section of the foot after death, or after amputation, all its soft tissues are found to be converted into a homogeneous, opaque, gelatiniform substance, traversed in all directions by canals, which communicate with large and small spherical cavities, varying in size from that of a pin's head to that of a bullet. The bones of the foot, as well as the lower ends of the tibia and fibula, are perforated in every direction by similar cavities, which, like those in the soft tissues, are filled with a soft material, usually yellowish, but sometimes pinkish, and sometimes black. It is with regard to the nature of this material which fills the cavities and canals, and which is from them discharged upon the surface, that the greatest difference of opinion prevails among those who have had opportunities of studying the disease. Dr. Carter, of Bombay, first gave prominence to the opinion that the disease was due to the presence of a vegetable parasite, and described the peculiar substance found in the diseased tissues, of the various colors above mentioned, as masses of fungus growth, a *mucor* or *chionophye*. Berkely, a leading mycologist, has pronounced a similar opinion as to their nature. Other observers deny that the disease is either in origin, or essentially, a mycosis, regarding it as of internal origin, and considering the occasional presence of possible fungus-growth as only accidental. Whether the disease be primarily deep-seated, establishing its connection with the outer surface and integument in its later stages; or whether it begins at the periphery, has never been definitely established, for want of proper study of its early stages. Its parasitic nature must still be held in doubt. Pathologists who deny this, have no explanation to give of the peculiar characters of its anatomical changes. The disease attacks men most frequently, and makes its appearance generally after adult life. Its tendencies are to a fatal termination after a long course. The only treatment found effective is amputation above the line of disease. A case closely resembling mycetoma has been described in this country by Dr. Kemper.¹

PARASITIC AFFECTIONS.

I. Vegetable Parasites.

There are three well-recognized diseases of the skin caused by the growth within its tissues of vegetable parasites. These are *Tinea favosa*, *Tinea trichophytina*, and *Tinea versicolor*. The growths which cause these affections belong to the lowest order of plant life, the fungi or moulds, and consist, as far as represented in such a phase of existence, of fine, cylindrical, thread-like, elongated filaments called *mycelium*; of minute, spherical, or ovoid cells called *spores*, or *conidia*; and of even more minute bodies, *micrococcus*, or *stroma*. These forms are capable of reproducing themselves, when transferred under proper conditions to the skins of other individuals. From what source they originally became parasitic upon man, or what their real botanical relations are to common moulds, we have no positive knowledge.

TINEA FAVOSA.—Favus, as it is commonly called, is the least frequent of these affections. It is characterized by the occurrence of yellow crusts upon the scalp or general surface, circular or ovoid in outline, and concave above. These vary in size from a minute point to half an inch in diameter, and are several lines in elevation above the surface of the skin at their edges. By

¹ American Practitioner, September, 1876.

confluence, however, the crusts may form larger patches of irregular shape, the peculiarity of this being caused by the seat of the patches and their method of growth. The minute elements of the fungus gain entrance to the tissues of the skin through the opening of the hair follicle, and from this as a central point extend downwards into the hair canal, and outwards in all directions into the epidermal layers. At first, a minute globular mass is formed, but, as the growth increases, it is held down at its centre, where it encircles the hair, while in the free epidermal tissues it is allowed an upward as well as a peripheral growth. Upon the scalp, where the hairs are most fully developed, the concave shape of the crust is longest retained, whereas, upon the general surface they lose this characteristic form when large, and project to a much greater elevation. If we remove one of the small and perfect crusts, which is easily done by any blunt instrument, we shall find its under surface convex, and that it is seated upon a smooth and shining, depressed surface of epithelial cells, upon which another crust is immediately reproduced. The color of the crusts in their central portion, or when small, is bright orange; fading when large, at the outer and older portions, to a pale lemon tint. Their odor is disagreeable and mouse-like, and they are of soft consistence. These appearances may be modified by rough handling on the part of the patient, or by the admixture of the fluid products of inflammation, pus, serum, or blood.

There is a stage, however, in favus, preceding the appearance of the crusts, which is generally overlooked upon the scalp on account of the presence of the hairs, and which is no doubt often mistaken for ringworm. It is best studied by observing the effects of inoculation upon other portions of the surface. This is most successfully accomplished by enlarging the openings of hair follicles with a needle, and by applying to the punctures some of the fungus rubbed up with water. In a few days, a red spot is noticed, which is somewhat scaly upon the surface, and which increases slowly in size, apparently returning to a natural condition in the centre as it spreads outwards, and with a slightly elevated border. Sometimes minute papules or vesicles may be seen within the patch. These appearances, so strongly resembling ringworm (*Tinea trichophytina*, in its circinate form), may last three or four weeks, and then, if the growth should not chance to establish itself within the hair follicles, may disappear without the production of a true favus cup or crust, though often minute masses of the characteristic yellow color may be seen. The error of mistaking this, sometimes called the ringworm stage of favus, for true *Tinea trichophytina*, and an occasional chance coincidence of the two diseases upon the same portion of skin, have given rise to the opinion, on the part of some dermatologists, that the fungus is identical in both affections.

The clinical proofs of the non-identity of the two diseases are found in the fact that pure ringworm occurs in thousands of cases without any development of favus: in the highly exceptional simultaneous or consecutive appearance of true ringworm in cases of favus; in the frequency of the former in communities, and the rarity of the latter, and in the varying relations of their comparative frequency both in different countries and in cities and rural districts; in the prevalence of ringworm of the scalp in orphan asylums for years continuously, without the production or transmission among the inmates of any parasitic affection other than itself; in the ease with which the one, and the difficulty with which the other, is communicated; and in the spontaneous transmissibility of both forms from man to the domestic animals, and back again through several hosts to the human subject—their individual identity being without exception preserved meanwhile. These, and other facts which might be mentioned, would seem to be conclusive in this matter.

The results of inoculation and of artificial cultivation, too, support the view of the specific individuality of these affections.

Upon the general surface, favus causes at times a slight degree of irritation, occasionally sufficient to excite an eczematous inflammation in the underlying and surrounding skin; but generally its presence is productive of little inconvenience. Upon the scalp, however, its effects are of a more serious nature. The hairs soon begin to change color, becoming gray or white, lustreless, stiff, and brittle, and after a while break off at the surface, or are discharged by suppuration with the surrounding favus masses. The disease spreads in time over the whole scalp, the loss of hair beginning generally at the front and lateral portions. The baldness may be only temporary, but in chronic cases the papillæ and follicular structures may be entirely destroyed by atrophy or by inflammation produced by the presence within them of the fungus growth. In this way is caused the firm, white, and glazed condition of the scalp, so characteristic of old cases of favus. In some instances, atrophy of the bones of the skull, even, has been observed. It can be easily understood that, by combing and scratching, or by rupture of the crusts in other ways, and by the use of bandages and caps worn to conceal the presence of the disease, favus matter may be transplanted from one part of the scalp to another.

Upon the constitution and health generally, favus has little or no effect. It is often seen upon sickly looking children, but such coincidence indicates merely a neglect most favorable to the progress of both the local and the general affection. It may possibly thrive more vigorously upon the devitalized epidermal tissues of a person debilitated by disease, but it occurs also upon those in robust health. Favus affects the nails, too, occasionally; generally in persons who either carry the growth in some other part, or have charge of those affected by it. The substance of the nails becomes yellow, opaque, and greatly thickened, and their surface becomes rough. A well-defined favus crust may sometimes form beneath them.

If we examine, with the microscope, the matter of which a favus crust is composed, upon whatever part of the body it may be growing, we shall find, in addition to modified epithelial cells: (1) innumerable minute cells of an irregularly ovoid shape, attached to each other in groups or rows, and about $\frac{1}{3000}$ of an inch in diameter; (2) others more or less swollen, elongated, divided, or branched; (3) long and very slender tubes, extending from the masses of cells, and more or less subdivided by partition walls, and branched; and (4) matter so small as to appear without definite form when examined by a very high power. The first two forms are the spores or conidia, the third is the mycelium, and the last micrococcus. The spores predominate in the centre of the crust, while the mycelium is found more largely at its periphery, extending into the surrounding epidermis, which holds it encapsuled. If we remove the hair which pierces the centre of the crust, with its sheaths attached, we shall find the walls of the latter distended with innumerable spores, and with the mycelium shooting out into the surrounding tissues. If the hair has been sufficiently long affected to present to the eye the appearances above described, it will be found when examined with the microscope, after maceration in a solution of potassa, to be permeated by canals running lengthwise between its fibres, and by beaded tubes extending longitudinally throughout its substance. Rows of conidia may also be seen encircling the shaft of the hair.

Favus is a rare disease in comparison with the other parasitic affections of vegetable origin. It is mostly met with upon the heads of poor children, for its elements seldom succeed in establishing themselves upon surfaces frequently washed or brushed. Although positively contagious, it is far less so than *Tinea trichophytina*, and never runs through schools and asylums like

the latter affection. It is frequently observed upon several members of the same family. It affects children more frequently than adults, and is rather more common in the country than in cities. It is found likewise upon domestic animals, especially upon mice, the crusts growing at times to such a size as almost to conceal the head. Cats which catch mice thus affected, exhibit well-marked crusts upon their paws, and sometimes communicate the disease to their kittens. Dogs, too, that have caught mice similarly diseased have had favus developed upon their forepaws. Numerous instances have been recorded in which the affection has been communicated from these animals to children playing with them. The disease has been observed also upon hens, and has been cultivated successfully upon rabbits. The presence of favus upon all these animals can be easily recognized, so that danger of transmission from such sources may be guarded against.

The course of the disease is always slow. Left to itself, upon the scalp, it may last a lifetime, or until it has entirely destroyed the hair. Upon other portions of the body, its duration is not so long, owing to the smaller size of the hair follicles.

Treatment of Favus.—In all the parasitic affections of vegetable origin, it is necessary to apply to the parts affected, such substances as will destroy the fungus growths without producing excessive action upon the animal tissues themselves. This difficulty greatly protracts the cure of these diseases. The number of parasitocides is by no means small—the most effective being preparations of sulphur and of mercury, tar, creasote, carbolic acid, and chrysophanic acid. They may often be combined with advantage. Upon the general surface, the crusts are first to be removed by softening them with fats or poultices, and then by thorough washing with soft soap and water. When the skin is exposed, it may be smeared with the following ointment, once or twice a day, as the skin bears it with or without much irritation: R. Unguenti hydrargyri nitratis, ʒij; sulphuris, ʒij; creasoti, gtt. xv; adipis, ʒss. M. As this ointment stains the surface, it should not be used upon exposed parts. Carbolyzed olive oil may be rubbed into the affected parts, or they may be painted with tincture of iodine, to which creasote has been added. Chrysophanic acid ointment (ʒj to ʒij) may be used, but with caution at first, on account of its irritating effects, and never upon exposed parts, because of its staining properties. A strong solution of sulphurous acid may be sopped into the affected skin, as freely and as often as the latter will bear it. Several of these methods of treatment may be advantageously employed at the same time, or alternately; for instance, the ointments may be applied at night and some of the washes in the morning, using them all as freely and in as concentrated forms as the skin will bear without becoming inflamed. Mercurial preparations cannot of course be used over extensive surfaces, nor for long periods, without danger. Treatment is to be kept up in all cases for a long time, it being a safe rule to consider the patient to be only half cured, when according to external appearances the disease has wholly disappeared, the plant retaining its vitality in the lower layers of the epidermis after its superficial growth has been destroyed. This rule holds true of all this class of parasitic affections.

Upon the scalp, additional means are necessary, because the large hair follicles are filled with the fungus growth to the base of the skin, and the presence of the hair prevents the entrance of the parasitocides to these great store-houses of danger. It is necessary, therefore, to remove the hairs. Epilation may be best performed with broad forceps. The diseased hairs and stumps come out readily, and with little pain. As many as possible should be extracted once or twice a day, after the removal of the crusts, the process being

extended a little beyond the affected patches, so as to include all possibly diseased hairs. After each sitting, the parts should be washed with strong soap and water, and should then receive some of the above mentioned applications. An ointment should be used for at least part of the day, as its action is more sustained and penetrating than that of the washes. The hairs which are removed each day must be burned, and proper precautions should be taken that the towels, soap, brush, and comb of the patient, as well as his head coverings, be not used by other members of the family. The process of epilation is to be repeated, as the hairs are reproduced, until they assume a healthy appearance and no longer contain any fungus elements. The treatment must be continued, generally, for months, to insure the complete eradication of the disease.

TINEA TRICHOPHYTINA.—This disease presents such different appearances, according to its seat, that its varieties have often been considered distinct affections, and have received separate titles. Ringworm of the scalp, called *Herpes* or *Tinea tonsurans*; ringworm of the general surface, called *Herpes circinatus*; ringworm of the beard, or *Sycosis*, at times called “barber’s itch,” as well as by other names; *Eczema marginatum*, a peculiar affection of certain parts of the body, so called by Hebra in his original description; and most of the cases of parasitic disease of the nails, called *Onychomykosis*, are all caused by the presence of one and the same fungus. They may be tabulated as follows:—

Tinea trichophytina	{	A. <i>Of general surface</i>	{ Tinea circinata, common ringworm. Eczema marginatum.
		B. <i>Of scalp</i>	{ Tinea tonsurans.
		C. <i>Of bearded face</i>	{ Tinea circinata, early ringworm stage. Sycosis parasitica, Tinea sycosis.
		D. <i>Of nails</i>	{ Onychomykosis.

Tinea Circinata.—The circinate form, or ringworm of the general surface, is familiar to everybody. It begins as a red spot, which is slightly elevated above the surrounding skin, and which is covered in a few days with minute papules, or with whitish scales. It increases rapidly in size, flattening down in the centre as it expands, so as to form a circular patch, the elevated border of which consists of a ring—an eighth or quarter of an inch, it may be, in width—of the same papules and whitish scales, while the central portion appears scaly and of a dull red color. Thus it goes on increasing in size, forming at times a complete circle of six or more inches in diameter, which then appears simply as a ring, as the redness and scalliness of the inclosed skin disappear after a time. Sometimes the disease starts up afresh, within the district already swept over, and thus rings within rings may be formed. Generally, after reaching any considerable size, the disease dies out at certain portions of the border or rim, for want of proper nourishment or suitable soil, and segments more or less broken are left to advance over the uninvaded regions of the skin. Generally, too, new spots, the result of self-inoculation, appear before the disease has lasted long, and run the same course. The seat of ringworm is most commonly the neck and face, and these are the parts most likely to be the first affected, from their greater exposure; but large surfaces of the body may be successively swept over before the disease is exterminated, or may exhibit simultaneously the characteristic marks of its presence. When about the face and neck, in children, it may extend its march to the scalp, and may thus give rise to one of the other varieties above mentioned; or, in a man, it may run through the beard, and cause there appearances similar to those upon the scalp in children, or may terminate finally

in another form, Sycosis. It may, however, affect the hairy portions of the face or scalp for a considerable time, and yet manifest itself in no other way than by the formation of the characteristic rings, remaining in the circinate stage. In the latter case, the hair follicles have not become deeply implicated, and the appearances and course of the disease, therefore, remain the same as upon the non-hairy portions of the body. Occasionally these varieties may be seen simultaneously upon one person, and their conversion into one another can sometimes be satisfactorily observed. The sensations which accompany them are more or less itching and burning.

Eczema Marginatum.—There is occasionally observed upon the central portions of the trunk, especially about the inner surface of the upper thighs and lower abdomen, an inflammatory condition of the skin, which Prof. Hebra was the first to particularly describe under the name *Eczema marginatum*. It begins as a small round patch of papules and vesicles, which itches excessively and excites scratching; as it spreads, it heals in the centre, sinking down and leaving a dark red, scaly condition of the skin, while the advancing border presents a constant, elevated ridge of papules, vesicles, and other lesions of eczema upon an inflamed base. The scratching and natural moisture of the parts aggravate the severity of the symptoms and tissue-changes, and give a markedly eczematous appearance to the part. The affection differs from ordinary eczema, however, in the central retrogression and the concentration of its activity at the advancing edges. It may extend thus over large and continuous portions of the trunk and limbs, but the appearances never vary from the type of the raised and narrow margin of papules, vesicles, excoriations, and crusts, and the dark red and scaly state of the parts earlier affected. The parasitic nature of this affection, and the identity of the fungus found in it with that of *Tinea trichophytina*, were demonstrated by Köbner in 1864. How then does it differ from ordinary ringworm of the skin? Only in the more eczematous character of the lesions which constitute the active, outer border, and the greater amount of congestion and pigmentation of the skin within it. This higher degree of inflammation must be due either to peculiarity of seat, or to the special temperament or tendencies of the individual affected. The former is no doubt the chief reason why ringworm of these parts should assume the peculiarities described as belonging to *Eczema marginatum*, for they are especially liable to eczematous inflammation. There is no doubt, however, that both position and personal tendencies operate in the production of the disease, for we may have ordinary ringworm of the same parts presenting none of the peculiarities of the *eczema marginatum* form, and, on the other hand, true eczema may affect them indefinitely as such, without becoming accidentally inoculated with the fungus of, and being converted into, ringworm. The affection then is to be regarded either as ringworm of certain parts, exciting an eczematous inflammation in addition to the lesions which it ordinarily produces, or as ordinary eczema, modified by the subsequent development upon it of the parasitic elements of ringworm. This variety of disease is not very common here, but in India is of frequent occurrence, where it is called Burmese ringworm. The subjective symptoms are an exaggeration of those of the ordinary affection.

Tinea Tonsurans.—Upon the scalp, the disease first manifests itself by the falling of the hair in circular patches. Examining the surfaces of these apparently bald spots, it will be seen that the hairs have not generally fallen out, but have broken off just above the scalp, leaving their stumps to project, and giving, with the scaliness of the early stage, now much more apparent, a peculiar roughness which is increased by a marked prominence of the hair

follicles. (In *Alopecia circumscripta*, which resembles *Tinea tonsurans* in configuration, the surface of the patches is perfectly smooth, free from scales, and almost wholly devoid of hair stumps.) At the borders of the patches, among the hairs not yet fallen, a rim of slight scabiness may be seen, where the early stage of the affection is in progress. There is seldom any redness or other sign of severe inflammation, in ordinary cases, but occasionally deep-seated inflammation of the hair follicles, with swelling and prominence of the skin, arises. A viscid fluid is discharged from several openings, and the whole elevated patch feels boggy. This condition is called *Kerion*. The course of the disease after it has attained its second stage, parasitic folliculitis, is always chronic; indeed, it may last for years, and extend over large portions of the scalp, which may be almost completely denuded of hair during the activity of the affection. Permanent baldness, however, seldom ensues, whatever the duration of the disease, unless the inflammation is so exceptionally severe in parts as to destroy the hair follicles. Such destruction, the result of small abscesses, is always very limited, and occurs mostly in children of strumous or debilitated habit. The absence of moisture, or crusts, in *Tinea tonsurans*, serves to distinguish it from eczema and favus, which, with seborrhoea, are the most common diseases of the scalp in youth. To distinguish it from the latter, and from other scaly affections of the part, the circumscribed baldness will be generally sufficient. For reasons not well understood, this form of *Tinea trichophytina* seldom affects adults, although ringworm of the face in men is not an uncommon affection, thus affording prolonged chances of its transmission to the scalp. With children, however, the disease is not of infrequent occurrence, especially in asylums where the most favorable opportunity for contagion prevails in the common use of brushes, combs, and towels, and where, if once introduced, it may affect a large part of the inmates, and require years for its eradication.

Tinea Sycosis. (Ringworm of the beard.)

First Stage.—It begins as upon non-hairy portions of the skin, in the form of small points, which generally attain the size of a pea, or are even larger, before attracting attention. They spread rapidly in a circular form, flattening down in the centre as the elevated margin of papules enlarges, and being accompanied by a considerable degree of itching and burning. The centres of the patches remain more or less reddened and scaly, but seldom present the white, brawny look, so characteristic of their seat upon the scalp. The sides of the face and neck are the most common starting points of the disease, and from these the rings may spread in every direction, or new ones may be started from the first, by self-inoculation upon other parts. The disease may thus run on for some time, without any apparent change in the hairs, but sooner or later, the period varying greatly in different cases, the hairs begin to fall from the parts affected, thus defining the patches more conspicuously than before. The hairs break off a short distance above the surface, leaving ragged stumps, as in the scalp. The disease may extend from the shaven portions of the face into parts of the beard worn long, or, beginning in the circinate form upon the neck, may spread upwards into the long hair of the face; but it seldom primarily gets a seat in a full beard. It rarely affects men who wear a full beard, or those who shave themselves, because it is almost always contracted at the barber's. No precautions in the way of separate shaving equipments at these places will insure absolute safety against such chances. Razors are rubbed upon a common stop; towels are used upon several persons in succession; and the writer has treated ringworm upon the fingers of barbers. In such ways the minute germs of the disease may be transferred from one affected individual to many who think them-

selves fully protected against the dangers of the barber's shop. After an indefinite period, varying from a few weeks to many months, it may be after the primary or circinate manifestations have apparently disappeared under treatment, the spores in many cases find their way to the depth of the hair follicles, and the second stage is developed.

Second Stage. (Parasitic folliculitis, or Sycosis.)—This is a most obstinate affection. It begins in the form of small nodules about the hairs, in some portion of the skin previously run over by the disease. These nodules slowly enlarge, and may discharge from their tips pus, which dries and forms crusts about the hair. In later stages, the nodules and pustules may be converted into large, prominent tubercles, which, by suppuration, may give rise to thick crusts; or large excoriated surfaces may be established. The tissues of the skin surrounding the diseased follicles may become involved to a great depth, causing extensive induration, swelling, and disfigurement of the parts. The disease may thus progress gradually over the hairy portions of the face, for months and years, producing, if the folliculitis is excessive, permanent destruction of the hair growth. It is not always easy, however, to distinguish Tinea sycosis from the non-parasitic folliculitis, and from eczema of the same parts. Generally, the morphological changes are much more grave in the parasitic form; its clinical history, moreover, will almost always establish the fact of a pre-existent ringworm; and the microscopic examination of the hairs removed from the least inflamed follicles, will discover the presence of the fungus. In eczema of the bearded face, the inflammation is not limited at first to the tissues immediately surrounding the follicles, and the serous oozing, suppuration, and crust formation, are not centred about individual hairs, but affect uniformly the surface involved. The infiltration of the tissues, too, is more general and diffused, not nodular. These three affections of the bearded face are often confounded under the common title of "barber's itch."

Onychomycosis.—Tinea of the nail remains to be described. Occasionally some one or more of the nails of persons affected with any of the above forms of the disease, or of those having the daily and long-continued care of such patients, lose their transparency, become opaque and dry, and gradually thicken. Their surface appears rough and cracks easily, and their free edge is blunted. Their substance becomes brittle, and flakes off superficially in the form of scales. Such cases form one variety of onychomycosis, of which favus of the nails is another.

Microscopic Appearances.—Microscopic examination of the scaly matter scraped from the surface of the skin in any of these forms of disease, shows innumerable round spores or conidia, $\frac{1}{7000}$ of an inch in diameter, arranged in groups or rows, and, sparingly interspersed with them, long and branching tubes of mycelium. In the affected hairs removed from the beard and the scalp, we find the spores between the sheaths in enormous quantities, and the cells of the cortical substance distended and forced apart by the parasitic growth. It will be readily seen why a hair permeated by the fungus should become brittle and break off with a splintered fracture just above or below the surface of the scalp. In the flattened cells of the affected nails, long chains of conidia, more or less branched, spores, and a few slender tubes of mycelium will be seen. The plant which produces this affection has been called *Trichophyton*.

Contagion.—The sources of contagion in all these forms of the disease are various. Of the habitat of the plant, outside of its parasitic life upon animals, we know nothing. It is probable, from its more frequent occurrence

upon man in America, that in its other phase of existence it is also more abundant amongst us than elsewhere. In children, ordinary circinate ringworm, occurring most commonly upon the hands and arms, face, and neck, is generally taken by playing with other children similarly affected, whereas the form which occurs upon the scalp is often taken by putting on the cap, or using the brush and comb, of another child who is already suffering from the disease. The obstinacy and duration of this latter variety of the affection, offer protracted chances of such communication. Upon adults, in the form of sycosis, the disease is almost always contracted at the barber's shop, by shaving, as above described; rarely at shops where only hair dressing is done. The marginate forms, occurring about the genitals, may possibly be conveyed during sexual intercourse. All forms, however, are intercommunicable. The frequent occurrence of the disease upon domestic animals is a common source of contagion. The animals thus affected are the cat, dog, ox, and hare. There is no reason for supposing any peculiar condition of the skin to be necessary for the development of the disease. There is no doubt a difference, according to individual cutaneous temperament and the general state of the economy, in the reaction of the skin under the parasitic irritation, and in the secondary manifestations, but nothing more than I have observed.

Treatment of Tinea Tricophytina.—In the ordinary circinate or ringworm stage, upon non-hairy portions of the body, the growth of the plant is quite superficial, and very simple agents are often sufficient to work an immediate cure, if thoroughly employed. Among these agents are acetic acid, carbolic acid in various forms, iodine, sulphurous acid, preparations of sulphur, tar, etc. The danger in relying upon them is that the disease appears to be well before the growth in the lower layers of the epidermis is destroyed. Treatment is therefore stopped, and relapses follow. Such imperfect management of the first stage of ringworm by the physician, is a frequent cause of the more serious forms of the disease. Generally speaking, it is necessary to continue treatment of the simple circinate variety long after all traces of the disease have disappeared. When it affects hairy parts, such as the scalp or beard, the time required for a cure is always much longer, and is certainly a matter of months—sometimes of many months. Inasmuch as the plant after a time extends to the very base of the hair follicles in these parts, that is, to the extreme depths of the skin, it is necessary to make the parasitocides employed penetrate to these depths, else they will not come in contact with the growth nor destroy it. For not only are the spores within the follicles protected from the action of these drugs by the presence of the hairs, but these are themselves filled with the cryptogamic growth. By pulling out the affected hairs, therefore, we not only remove a part of the disease at once, but also open the hair sacs to the entrance of our remedies. Epilation then must be regarded as a necessity, when the disease affects the beard or scalp. Cases may indeed recover without resorting to it, but the cure is, under such circumstances, much more uncertain and protracted. Not only the stumps within the affected district, but the hairs immediately surrounding it, and not yet showing signs of disease, should be removed. They are easily extracted with broad-bladed forceps, and should be burned as soon as pulled. There is of course no danger of permanent baldness from such pulling, and the new growth which follows has to be removed in some cases a second time. As many hairs as possible should be extracted at one sitting without producing too much irritation in any one portion of the diseased patch.

The choice of parasitocides must depend in some degree upon the seat, extent, and surface condition in individual cases. Where the accompanying eczematous inflammation is especially severe, or where the deeper-seated in-

flammation is intense, as in *Tinea sycosis*, it is sometimes necessary to employ preliminary treatment before the proper antiparasitic remedies can be used. For the ordinary superficial circinate forms, a solution or ointment of the corrosive chloride of mercury (gr. ij to ʒj), if the surface affected be not too extensive, may be applied twice a day as freely as the skin will allow without over-stimulation. Upon the face and other parts exposed to view, these may be used to advantage, because they do not discolor the skin. Iodine, as a tincture, or rubbed up with equal parts of iodide of potassium and glycerin, may be painted upon the affected surface. Sulphurous or carbolic acid in solution, may also be applied with success, though less certain in their action. These should all be used much longer than the appearances seem to require. An ointment of chrysophanic acid or Goa powder (ʒss or ʒj to ʒj) may be used upon parts protected by the clothing. When the disease affects the beard or scalp, and has already invaded the hairs, our remedies must be used for a long time, and in connection with epilation. Some such course as the following may be used: at night, an ointment made up in varying proportions, but substantially as follows—Hydrargyri ammoniati ʒj, creasoti gtt. xv, sulphuris sublimati ʒss, adipis seu vaselini ʒj—is rubbed thoroughly into, and a little beyond, the affected districts. In the morning, this is washed off with soap—with soft soap if well borne—and epilation is then performed. Immediately afterwards, the officinal solution of sulphurous acid is sopped freely over the parts, which are then left to themselves for the day.

The face will not stand as rough treatment as the scalp, and soothing ointments, such as those of zinc or diachylon, must often be used by day to counteract the over-activity of the nocturnal remedies. Quick cures are impossible; sure results are to be attained only by the long-continued use of the most active remedies, thoroughly applied. Even by such use, and long after the faith and endurance of patients and attendants have been tired out, relapses will often occur after treatment has been given up, because there has been left undestroyed in the deep recesses of some hair follicle a single spore of the many millions first attacked. No internal remedies have any direct effect upon the destruction of the fungus. The clothing worn next the parts affected should be soaked in boiling water, or destroyed, and the brushes, combs, and other articles, which have come in contact with the diseased skin, should be treated in the same manner.

TINEA VERSICOLOR. (Synonym: *Pityriasis versicolor*.)

This disease is characterized by the presence of yellowish or dark-brown spots of irregular outline, but slightly elevated, and covered with fine scales which are easily scratched up by the nails, or removed by scraping with a knife. They vary in size from minute points to confluent patches covering large portions of the chest or abdomen. They chiefly affect the front of the trunk—beginning generally upon the chest—and may extend downwards so as to cover more or less wholly the abdomen, hips, and upper thighs; may pass upwards to the shoulders, and thence down to the forearms; or may creep around the chest to the back. They rarely appear below the knees and elbows, or ascend upwards upon the neck, and they never affect the face. In other words, they do not generally grow upon those parts of the skin which are exposed to the air and light, finding rather upon those parts protected by clothing, the warmth, and possibly the absence of light, essential to the development of the plant, upon the presence of which the disease depends. It seldom, if ever, occurs upon children, which fact may be explained, perhaps, by the choice which the parasite shows for the dry and outer cells of the epidermis, those of adult life being probably better adapted in this respect to its

needs. When once established, it seldom disappears spontaneously, but may go on for years, perhaps dying out largely during the winter, to revive and extend over wider areas during the summer. It often gives rise to great itching of the parts affected, although in some cases the patient is not made conscious of the presence of the disease by any subjective symptoms. It is often mistaken for the pigment stains upon the skin, called *moth* or *chloasma*, an affection which differs from it in position, course, and clinical history. It is of quite frequent occurrence, although its presence is often overlooked by its host, and is discovered by the physician when examining the naked chest for other purposes. It is for this reason only that it is so often found upon consumptive patients, for its growth is entirely independent of the general condition of the person affected, nor does it exert any injurious influence upon the same. It is positively contagious, although by no means so easily communicated to new hosts as ringworm; and its direct transference from one individual to another is seldom observed except among those living in the closest personal intimacy. Upon the domestic animals it has never been observed.

Microscopic Appearances.—If some of the scales removed from a patch of the disease be treated with a drop of potassa solution, and examined with the microscope, countless numbers of round conidia or spores are seen, grouped in clusters, of high refractive power, and resembling minute oil globules. Associated with these are fine tubes of mycelium, running in a network of endless intricacy. The growth extends but slightly within the hair follicles. The plant concerned in the production of this disease has been called *Microsporon furfur*.

Treatment.—As the growth is very superficial, less active parasitocides are required for its destruction than in cases of favus or ringworm. Thorough sopping with sulphurous acid, morning and evening, is a cleanly method of treatment, but is objectionable on account of its suffocating properties when applied over large surfaces. Oil of turpentine, rubbed into the parts at night, will be generally well borne, and is an effective remedy. A sulphur ointment mixed with creasote (Sulphuris 3ss, creasoti gtt. xv, adipis 5ij) may be rubbed in every night, as thoroughly as the individual's skin will allow, and is then to be washed off in the morning with tar soap, or, if the skin will bear it, with soft soap. Mercurial preparations cannot be employed when the affected surface is extensive. Whatever remedies are used, are to be applied continuously for long periods, even after the disease has apparently disappeared. Unless this precaution be followed, the growth will surely revive after a longer or shorter period.

II. *Animal Parasites.*

The animals that are strictly parasitic upon man, those, that is, that attach themselves to him throughout all the phases of their existence, and derive their sustenance from his tissues, are few in number. They are: *Demodex folliculorum*, *Sarcoptes hominis*, *Pediculus capitis*, *Pediculus corporis*, and *Phthirus pubis*. There are many others which prey upon man to a greater or less extent, but which are not strictly parasitic upon him, such as fleas, gnats, ticks, bedbugs, etc.

DEMODEX FOLLICULORUM.—This minute mite, which inhabits the hair follicles, needs only a mere mention, as it gives rise to no phenomena, is of frequent occurrence upon healthy skins, and requires no treatment.

SCABIES.—The symptoms produced by the presence of the itch insect (*Sarcoptes hominis*) upon the skin, are of two kinds: those caused directly by the animal itself, and those produced in consequence of the scratching of the patient. The males and immature insects make only a little pit in the cuticle, for purposes of nutrition or metamorphosis, which gives rise to a minute papule or vesicle. It is the impregnated female only which produces the pathognomonic mark of scabies, the burrow for the deposition of her eggs. These burrows appear as linear ulcerations of irregular course, with an uneven surface corresponding to the situation of the eggs within, and terminating in a marked prominence representing the position of the animal beneath the epidermis. In persons of cleanly habits, the burrows are generally distinguishable by their white color, but in working people they are mostly stained of a darker tint by the absorption of dirt. They vary in length from one or two lines to half an inch, but in exceptional cases they may exceed this measurement. Their direction is slightly zigzag, or curved, seldom perfectly straight. In some cases the whole burrow is lifted prominently above the general surface by the exudation beneath it. If the portion of epidermis in which the burrow is situated be cut out with a pair of curved scissors, and examined with a low magnifying power, it will be seen to pursue an oblique course downwards, and to contain numerous eggs, in various stages of development, broken egg shells, and an abundance of reddish fecal matter in small globular masses.

The name of the disease indicates plainly enough the nature of the subjective symptoms which characterize it: "the itch." The rambling of the insects over the surface, and the burrowing into the deeper sensitive layers of the epidermis, produce an irritation so intolerable as to make a resort to scratching an imperative necessity. This leads directly to the secondary phenomena of the disease, the eruptive appearances of scabies. In the beginning of the disease, the itching is very slight, but after a fortnight, when the young emerge from the burrows and begin to colonize fresh portions of the skin, it increases in intensity, and by the third week is no longer relieved by superficial friction. An excoriated papular efflorescence bears witness to the violent action of the nails. Finally, vesicles, pustules, patches of moist eczema, and ecthymatous eruptions follow. These appearances are most marked upon certain regions of the body—the chest, abdomen, thighs, buttocks, and hands—not the parts where the burrows are in greatest abundance necessarily, but those which are most accessible to the nails. In old cases, in addition to the above lesions, we may find ecthymatous sores of enormous size, with deep pigment stains and swollen glands, presenting the most varied manifestations of cutaneous efflorescence. A peculiar and rare form of the disease, in which the animals live in colonies beneath extensive crusts upon the surface of the skin, instead of burrowing into the epidermis, has been called "Norway itch." Such a radical change of habit on the part of the insects is inexplicable.

The favorite seats of the burrows are the lateral surfaces of the fingers, the wrists, nates, folds of the axillæ, and penis, while in infants they may be distributed over the whole surface. They do not affect the head. The secondary forms of eruption are much more widely spread. The most important points in diagnosis are the seat of the eruption, the great multififormity of the efflorescence, the aggravation of the itching while the patient is warm in bed, a history of contagion, or the occurrence of similar symptoms in several members of a family or amongst associates, and the presence of the characteristic burrows. From the latter, it is always easy to remove the old female, or some evidence of her presence, with a needle, or the young insects may be found, perhaps, in a vesicle or papule.

Scabies, in America, is a very fluctuating affection in point of frequency. In the early part of the present century, it was as prevalent among children as the exanthemata, but afterwards, and until the time of our civil war, had nearly disappeared. During the camp life of that period, it found the most favorable conditions for rapid development and general distribution. Soldiers returning on leave, transplanted it in their homes all over the country, so that it became a universal evil. Since then it has been almost exterminated, reviving to a slight extent, from time to time, in direct ratio to the amount of foreign immigration.

Treatment.—There are two distinct purposes to be accomplished in the treatment of scabies: one is to destroy the animal in all its phases of existence, the other to cure the cutaneous disturbances. Unfortunately, the first necessity can be effected by such remedies only as tend to aggravate the condition of the latter, so that in every individual case, the treatment must be prudently adjusted to meet these two objects. In many cases, preparatory treatment even is necessary in order that the inflammatory processes in the cutaneous tissues may be sufficiently reduced to bear the action of the parasiticide. In the majority of cases, however, the two objects may be accomplished simultaneously by a combination of methods. When the skin is greatly inflamed, covered to a large extent with excoriations and pustules, or in a state of acute œdematous eczema, vesicular and oozing, the methods already advised for the management of such conditions (see Eczema, p. 58), should be employed until the inflammation has been sufficiently reduced to endure the stimulating action of the other class of remedies. This will sometimes require a week or more.

The most active agents that can be used upon the skin for the destruction of the itch insect and its eggs, are sulphur and Peruvian balsam. They must be employed in such a way, however, that they will penetrate to the haunts of the insect within the epidermis, as well as upon its surface. The addition of an alkali is of material assistance in this direction, by removing the outer layers of cuticle, and such a combination forms the basis of all the so-called "quick cures" of the disease. The three most effective preparations of this class are: Helmerich's ointment (sulphur, two parts; carbonate of potassium, one part; lard, eight parts); Wilkinson's ointment (sulphur, oil of cade, green soap, and lard, equal parts); and Vlemingcx's solution (sulphur, two parts; caustic lime, one part; water, twenty parts. Boil down to twelve parts and filter).

The patient is first rubbed thoroughly over all affected parts with one of these, spread on a bit of flannel rag. He is then allowed to lie in a warm bath for half an hour, when the skin is rinsed in fresh water, and rubbed with some soothing ointment or simple lard wherever excoriations exist. This process is to be repeated for three or four nights in succession. The thoroughness of the applications is to be limited only by the endurance of the individual's skin, and the amount of inflammation it presents. No parts except the head are to be spared. Instead of the lard, in the Wilkinson's ointment, alcohol may be substituted, as recommended by Hebra, this giving greater penetration to the parasiticides in its composition.

These are the most powerful means of treatment, and are especially serviceable in cases of long standing and extensive distribution. The itching usually disappears after the first night's application. In milder cases, and in women and children, less severe measures may be employed, if desired—a mixture of sulphur and styrax, or Peruvian balsam, is generally effective, and not offensive or irritating. The following formula is a good one: R. Sulphuris ʒss, balsami Peruviani ʒj, adipis seu vaselini ʒij.—M. It is to be rubbed

thoroughly into all affected parts at bedtime, and, if possible, allowed to remain upon the skin all night. If too stimulating for such protracted action, it is to be washed off after an hour in a warm bath. This process is to be repeated for several nights in succession. Upon very delicate skins, the Peruvian balsam may be used alone, mixed with alcohol or olive oil. Whatever method is employed, it must be remembered that the secondary eruption remains to be treated, after the parasitic element of the disease has been exterminated. In mild cases this will disappear of itself, but in the severer and long-standing forms of the affection, it is necessary to apply the same principles of treatment as are required in eczema. It must also not be forgotten that a continuance of the use of parasiticides, after they have accomplished the destruction of the animal and its eggs, may provoke appearances which the physician creates while endeavoring to cure, and that the skin after a severe attack of the disease is often left in an irritable state for a long time. All underclothing worn next to the patient's skin, as well as the bed linen, should be put into boiling water on the first night of treatment.

PEDICULOSIS. (Synonyms: *Phtheiriasis* ; *Louse disease*.)—The lice which infect man are of three distinct species, and they inhabit distinct regions of the body. They are: the head louse (*Pediculus capitis*), the clothes or body louse (*Pediculus vestimentorum*), and the pubic louse (*Pediculus* or *Phthirus pubis*).

Pediculosis Capitis.—The head louse lives only upon the hair of the head, to which it attaches its eggs, popularly called “nits,” and subsists by puncturing the scalp and drawing blood through the bite. It multiplies very rapidly, and produces great irritation of the scalp. In consequence of scratching or combing, acute eczematous inflammation of the scalp is often excited—Eczema madidans or Eczema pustulosum—so that the hair is glued together by the discharges, forming with the lice an indescribably filthy mass. The glands in the neck often become greatly swollen, and the eczema may extend from the centre of the scalp to its border, in all directions. A sympathetic eczema is often established about the ears, mouth, and nostrils, in children, even when the scalp is not visibly affected. Head lice are very common among the dirty classes of society, and often find their way to the most cleanly households, through the meeting of children at public schools, through the intercourse of wet nurses with lying-in women, and, no doubt, sometimes through accidental contact in public conveyances.

Treatment.—The most effective way of destroying head lice is by saturating the scalp and hair, throughout its length, with crude petroleum, and washing it off after two or three hours with soap and water. When dried, the hairs should be drenched with alcohol or cologne. This process should be repeated for two or three days in succession. The nits may remain attached to the shafts of the hairs for some time afterwards, but are harmless. They may be removed by scraping with knife or scissors. It is never necessary to cut the hair before treatment. Mercurial, stavesacre, and cevadilla ointments are often used to destroy the lice, but their effect is more uncertain than that of petroleum. The eczematous condition of the scalp, which remains after the destruction of the parasites, generally subsides rapidly, without treatment, but sometimes demands subsequent attention. All head coverings which have been worn in contact with the hair, should be cleansed by boiling or baking, or their linings should be destroyed. Combs and brushes may be cleansed with boiling water. They should never be used for the removal of the lice.

Pediculosis Corporis.—The body louse is, strictly speaking, a *clothes louse*, for it breeds upon the clothing, and only bites the skin to draw blood as its food. It is somewhat larger than the head louse, which it closely resembles. It lays its eggs in the folds and seams of the garments, and its eggs may be readily discovered by examining these parts. Its bite or puncture produces a minute, papular efflorescence, which by scratching generally exhibits a tip capped by dried blood. The whole surface of the body, excepting the head and hands, may be thickly covered in this way, with long scratch marks interspersed. The eruption is generally most marked upon the trunk, especially so upon the upper parts, front and back. When lice have infested the body for a long time, it may be during the whole life, as among the filthy races of some parts of Europe, the skin, in addition to this excoriated, papular eruption, may present much graver lesions, such as pustules, ecthymatous crusts, and extensive sores, and may gradually take on an intense degree of pigmentation, as the result of the long-sustained hyperemia of its tissues. Such a condition has been called “vagabond’s disease” (*Morbus erronum*).

Treatment.—This is to be directed to the clothes, not to the skin, which in ordinary cases rapidly recovers its healthy condition after the lice have been destroyed. All the clothing that can be so treated, should be thrown into boiling water, and the outer garments should be baked, or ironed along all their seams with as hot a flatiron as can be used without burning them. The bedclothing may be treated in the same way, but this is rarely necessary. The body may be thoroughly rubbed with soft soap, and soaked in a hot bath, before putting on fresh clothing. Mild, soothing ointments may sometimes be used upon the skin for a few days, with advantage, to quiet the irritability of its nerves.

Pediculosis Pubis.—The pubic louse (*phthirius*) differs materially in shape from the pediculi of the head and clothes, being shorter and broader. It attaches itself to the hairs of the pubic region, and to those of the legs and surface of the abdomen, in hairy men. It is found also in the axilla, and, in rare cases, even upon the eyelashes. It has a reddish color. Its eggs are attached to the hair in all these regions. It draws blood from the skin at the roots of the hairs, and produces great irritation, in consequence of which a papular eruption is developed, and often acute eczematous inflammation. Pubic lice are generally acquired during impure sexual intercourse.

Treatment.—These lice may be destroyed by smearing the parts, if not too extensive, a few times with mercurial ointment, but better generally by the use of petroleum, in the manner described in speaking of *Pediculosis capitis*.

NOTE ON THE PATHOLOGY OF LEPROSY.

In 1873, Hansen called attention to the presence of bacteria in leprosy tissues. Within the last year or two this subject has received particular study from many observers, especially Neisser, Cornil, and Suchard. According to these writers, the same forms of bacilli have been found in leprosy neoplasms derived from patients in many parts of the world where the disease exists. These organisms are staff-like or rod-like bodies, having a length of from half to three-quarters that of a red blood corpuscle, and a breadth one-fourth of their length. They occupy the large round cells, which are so abundant in the fibrous structure of the skin in leprosy tubercles, distending the protoplasm at times by their great numbers. They are arranged in parallel rows, or are placed end to end in chains of two or three. They are not found in any epithelial tissues nor in the bloodvessels.

Neisser draws the following conclusions from his investigations : Leprosy is a true bacterial disease, caused by a special bacterium. The bacilli appear in the tissues as such, or more probably as spores, and remain for a longer or shorter time, according to circumstances, in a state of incubation in depots, perhaps in the lymph glands. This period of incubation, much longer than in other infectious diseases, is in proportion to the physiological resistance of the human organism compared with the feeble developing power of the bacilli. It, as well as the course of the disease, is shorter in tropical countries than in Europe. From these depots, the disease extends throughout the body ; in those portions of the skin most exposed, the face, hands, elbows, and knees ; and in the peripheral nerves (anæsthetic form). The other organs are less freely invaded. The bacilli excite inflammation, and by a specific action transform the migrating cell into a leprous cell. Leprosy is probably an infectious disease, and its specific products are contagious, viz., the leprous cells of the tubercles, the tissue fluids, and pus containing bacilli and spores. On the other hand, all pus may not be infectious, as the fluid contained in leprous bullæ is not. Leprosy is not hereditary.

DISEASES OF THE CELLULAR TISSUE.

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AN "atmosphere of areolar tissue" envelops all the organs, as well as the component elements of each organ. As the *tela cellulosa*, it extends in one continuous subcutaneous layer from head to foot, sending in prolongations which support, strengthen, and give shape and consistency to every part. A tissue like this, having so unusual a dissemination, and having such close relations to bloodvessels, nerves and lymphatics which traverse its meshes, must necessarily be the seat of varied and complex pathological phenomena, interesting alike to the student and practitioner. Yet, strange to say, there is nowhere any practical classification which might serve as a guide in the investigation of such affections. Some of the diseases of the areolar tissue are described in surgical works under the head of abscess, which is only one of many equally important results of inflammation of this tissue. Others receive a passing mention when they form connecting links between morbid changes in neighboring organs; and in a few instances the affections are designated by names which have little or no relation to the anatomical site of the disease concerned, or to the pathological changes which take place. The limitations of this article necessarily exclude many diseases of the cellular tissue which come under the care of the physician and gynæcologist; and also curtail to some extent the completeness of description which would be necessary in a work devoted solely to the subject.

The diseases of the cellular tissue which belong to the domain of Surgery may be advantageously classified as follows:—

(1) Inflammation of the cellular tissue, which may be either *simple* or *malignant*. The former may be either diffused or circumscribed; the latter is always diffused. The circumscribed varieties of *cellulitis simplex* are: (a) Peri-venous Cellulitis; (b) Peri-arthritic Cellulitis; (c) Ischio-rectal Cellulitis; (d) Peri-urethral Cellulitis; (e) Peri-phalangeal Cellulitis; (f) Pericæcal Cellulitis; and (g) Orbital Cellulitis.

(2) Gangrenous Cellulitis.

(3) Phlegmonous Erysipelas.

(4) Hypertrophy (Myxœdema).

(5) Atrophy.

(6) Tumors of the Cellular Tissue.

(7) Parasitic Affections of the Cellular Tissue.

Gangrenous cellulitis or carbuncle, phlegmonous erysipelas, and tumors of the cellular tissue, are described in other articles, and will not therefore be touched upon here.

DIFFUSED SIMPLE CELLULITIS.

Simple diffused inflammation of the areolar tissue may be either acute or chronic. The acute form is the most common. The chronic is generally seen in connection with old ulcers and badly treated wounds in uncleanly persons. Occasionally it follows the acute variety. It is rarely, if ever, the result of blood-poisoning. In this particular it differs from malignant cellulitis, which invariably results from a septicæmic condition.

LOCALITY.—The most frequent seat of *cellulitis simplex* is in the cellular tissue of the upper and lower extremities. Among the predisposing causes of the disease are: the use of innutritious food, impure air, mental distress, venereal excesses, or the prolonged abuse of alcoholic liquors. The most frequent of the exciting causes are exposure to cold and traumatism. In the upper extremity, idiopathic cellulitis usually attacks the inner and anterior aspect of the arm and forearm. In the lower extremity, it is found generally on the outer and anterior portions of the leg. It is not infrequently met with at the upper part of the thorax near the axillary region, at the lower portion of the abdominal walls, and in the areolar tissue around the gluteal muscles. Traumatic cellulitis may occur in any part of the body at the seat of injury.

SYMPTOMS.—At the onset of the inflammation there is a soreness of the affected part, with occasional shooting pains, deep-seated, and accompanied by slight swelling and hardness of the tissues under the integument, without any perceptible redness. The involved limb feels stiff, and some pain is present at every movement. The pain soon increases in severity, and the swelling and hardness become more perceptible. The tumefaction is often irregular in shape, with patches between the swollen spots, which, though inflamed, are softer, gradually shading off into the surrounding tissues. When the disease is fully developed this irregularity may disappear, and the surface becomes smooth and glistening. In cases where the lymph coagulates in the vessels, the hardness and roughness, unaccompanied in many cases by redness, remain through the disease, and for some time after all acute symptoms have passed away. With the acute swelling and infiltration of the tissues by inflammatory products, there is a more acute and throbbing pain than before, and the limb cannot be moved without great suffering. Suppuration is announced by the occurrence of chilly sensations or rigors, and by a softening of a portion which was previously hard and tense, and by fluctuation. The suppuration occurs in patches, which finally bleed, and form long, irregular, subcutaneous sinuses that communicate with each other, and are exceedingly difficult to heal.

When, on account of the depth of the pus from the surface, fluctuation cannot be ascertained with any degree of positiveness, dependence must be placed on the occurrence of rigors, the subsidence of acute pain, and the fact that the pits made in the tissue by pressure are exceedingly deep, but do not remain as long as those made when simple inflammatory œdema is present.

The anatomical changes consist in a varicose dilatation of the capillary bloodvessels of the inflamed district, and in some portions a breaking down of their walls—the adjacent parts of the still intact vessels being closed by coagula, and by pressure from without of the various exudates. The connective tissue cells are found in various stages of proliferation, and wandering cells (white blood-cells) infiltrate the inflamed tissue throughout its whole extent. The inter-cellular substance is opaque and shreddy, filled with cells, and sometimes with minute masses of blood which have escaped through the softened

wall of a capillary vessel. As in other inflammations, the chlorides and phosphates are in excess. A large amount of lymph and serum is also present. At a later period collections of pus are scattered through the inflamed part, and shreds of necrotic tissue are interspersed with the various exudates.

There is always more or less febrile disturbance during the progress of the disease. Its extent varies with the amount of tissue involved in the inflammatory action. The temperature rises from one to three degrees. The pulse is increased in rapidity, rarely rising, however, above one hundred and ten, except in very nervous persons, when it may reach one hundred and twenty or one hundred and thirty beats per minute. The tongue is coated with a whitish fur in the early stages, but afterwards may assume a brownish color, especially if the patient's power of resistance be feeble, or if there be much suppuration going on. There are some headache and pain in the back, and the bowels are usually constipated. Chills are present when pus forms.

In the subacute or chronic form of simple cellulitis there are no constitutional disturbances of any importance. Neither is there any special amount of pain, except when the involved limb is moved, or when pressure is made. The tissue is hard, dense, and roughened, and there is more discoloration of the integument than there is in the acute form.

DIAGNOSIS.—Cellulitis simplex is readily diagnosed from *phlegmonous erysipelas* by the absence of the purplish redness and of the burning, throbbing pain, which characterize the latter affection. In cellulitis simplex there is, as a rule, comparatively slight fever, and the general distress is much less, in every way. In phlegmonous erysipelas the febrile symptoms are of a much graver type, and in the latter also there are constitutional symptoms before the local manifestations, while in simple cellulitis the local symptoms always precede the constitutional.

Cellulitis maligna is readily distinguished from cellulitis simplex by the very rapid extension of the inflammatory action, the great tumefaction of the diseased limb, the accompanying lymphangitis and lymphadenitis, and the exceedingly grave constitutional disturbance which attends it, and by recurring to the fact that malignant cellulitis follows the introduction of some septic material into the circulation.

TREATMENT.—This should be both local and constitutional. A mild mercurial or saline purgative is necessary at the onset, to produce a complete evacuation of the intestinal canal. The cathartic should be followed by large doses of quinine (twenty to forty grains daily) for three or four days, unless there is some special contraindication to its use, in the shape of an irritable stomach or headache. In such cases, ordinary tonic doses may be given with safety. This drug is often effective in cutting short the inflammatory action, and in limiting the extent of the suppurative processes. When the use of quinia is undesirable, and the fever is of a low type, beef-tea and wine will be found an efficient substitute. If the temperature runs high, the tincture of aconite in minute doses (one-fifteenth of a drop), repeated every half hour, may be given with benefit. When suppuration has commenced and the fever has subsided to some extent, the muriated tincture of iron should be administered in large doses. It may be given combined with the tonic doses of quinia. Opiates are not advisable unless there is great restlessness and inability to sleep, and even in such cases, alcohol in some form at bedtime is preferable. Sponging the surface of the body with tepid water and alcohol, with gentle friction of the affected limb, some distance from the seat of inflammation, will often relieve the pain and restlessness and promote sleep, without the assistance of any drug.

In the local as well as in the general treatment, attention must be given to the idiosyncrasies of the patient. It is well to remember that "what is one man's meat is another man's poison." If the patient has had a previous attack of cellulitis, it will be useful to learn whether hot applications were more soothing than cold ones, or *vice versa*. When the system is not depressed, and the general condition is good, cold applications to the part by means of rubber ice-bags will often allay the pain; diminish the swelling, lower the general as well as the local temperature, and limit the disease. If the patient is very sensitive, the ice-bags may be separated from the integument by a folded towel. These cold applications may be continued until suppuration supervenes; when that occurs they should be discontinued.

If the patient is very weak, and if any purplish discoloration of the integument is present, indicating a tendency to stagnation of blood, cold applications will not answer. They are also contraindicated in subacute or chronic cellulitis, because they conduce to the formation of gangrenous sloughs, and retard the return to a healthy state. In all such cases hot applications are the best. Pieces of heavy blanket or folded towels, dipped in hot water, may be applied, and frequently changed. When the cloths are wet, a few drops of laudanum, or of the *lotio plumbi et opii*, may be poured on the surface next to the skin. This preparation acts in conjunction with the hot water, in exerting a sedative effect, and in relieving the pain. Some recommend clay poultices, in all stages of the disease. Poultices made of linseed meal, slippery elm, bran, etc., are also used. Charcoal poultices are excellent when suppuration is going on.

As the areolar tissue is readily permeated by the exudates, and as the pressure of the exuded material on the bloodvessels of the part soon cuts off the supply of nutriment and causes necrosis of the inflamed tissue, it is well, in the early stages of the disease, to resort to free incisions; and since, as before remarked, the tendency in all cases of cellulitis is to early suppuration and the formation of sinuses which are exceedingly difficult to heal, the use of the knife is indicated before pus forms, while the acute stage is at its height. Leeches or cathartics will not answer the purpose. Early and free incisions will generally retard the disease, and prevent extensive suppuration and the formation of sinuses.

Some surgeons object to early incisions, on the ground that the bloodvessels opened by the knife afford a means of contamination to the general system by pus and poisonous germs; but this objection would be as rational at any period of the disease, and would prevent incisions even after the formation of pus. It must not be overlooked that the destructive poisons at work in the interior of the diseased tissue break down the walls of the lymph channels and capillary bloodvessels, produce coagula in veins, and confine a mass of poisonous material where it can gain a ready access to the general circulation and excite serious constitutional changes. If early incisions are made, and if the parts are afterwards thoroughly cleansed with carbolized water, no danger from blood-poisoning need be apprehended; indeed, experience shows that there is much less danger than when purulent formations are allowed to take place, and the pus is permitted to burrow in the neighboring tissues.

When the parts have been sufficiently incised, a poultice, made of equal parts of linseed meal and charcoal, should be applied for three or four days. At the end of that time frequent syringing with carbolized water, or with a solution of chloral hydrate (five grains to the ounce), will be sufficient. When granulations spring up, a dressing of balsam of Peru will be of advantage.

Another good method of treatment, which has been employed with success in traumatic cellulitis, is to immerse the inflamed limb in a tin or zinc basin filled with water at blood-heat, or as high as 110° F.; when suppuration has commenced carbolic acid may be added to the water. The limb

may be left in the bath during the whole course of the disease, both before and after the incisions are made. The water should be changed twice in twenty-four hours, and the sinuses and incisions thoroughly syringed each time.

In the chronic form of simple cellulitis, frequent rubbing with oleate of mercury, and strapping, are all that is necessary in the way of local treatment. Cod-liver oil and iron should be given, and a strong diet, until the disease is cured.

CIRCUMSCRIBED SIMPLE CELLULITIS.

The most common forms of circumscribed cellulitis which come under the care of the surgeon are, as already mentioned:—

- Peri-venous cellulitis.
- Peri-arthritis cellulitis.
- Ischio-rectal cellulitis.
- Peri-urethral cellulitis.
- Peri-phalangeal cellulitis.
- Peri-cæcal cellulitis.
- Orbital cellulitis.

PERI-VENOUS CELLULITIS, erroneously denominated *suppurative phlebitis*, is a comparatively rare form of disease, and, with the exception of peri-cæcal cellulitis, is much graver in its consequences than the other varieties. The gravity of peri-venous cellulitis arises from the close proximity of the inflammation to the venous channels, and to the destruction of the walls of the veins, through the absence of their supply of nourishment in consequence of the small vessels which supply the walls with blood being pressed upon and closed by the inflammatory exudation. The destruction of the walls of the veins allows pus and other forms of degenerated material to enter the general circulation, and thus excite pyæmia, which not infrequently accompanies this form of cellulitis.

Peri-venous cellulitis, like other forms of cellular inflammation, is likely to occur in persons whose vitality is depressed, and who, while in that state, are accidentally or surgically injured in the neighborhood of a vein. It may accompany any form of injury or operation on the extremities, but is especially apt to accompany lacerated or torn wounds. It usually commences around some of the smaller veins, and extends upward to the larger branches until the main trunk is reached. The inflammation travels with great rapidity, and death of tissue occurs sooner than in any other form of simple cellulitis. The exudation of inflammatory material is similar to that previously described, and the pathological changes generally are the same, with this exception: coagulation of blood occurs in the veins, consequent upon obstruction to the circulation through them; and the œdema of the extremity, at a distance from the seat of inflammation, is due to the same cause.

Symptoms.—The symptoms usually are not well marked during the first twenty-four or forty-eight hours. During that period there are some pain and swelling of the affected part, not well defined. On the third or fourth day the redness is increased, and the swelling and hardness reach their maximum over and around the venous trunk. The exudates around the vein and the coagulum within the vein make the whole feel like a cord under the integument. If the vein is deep-seated, a diagnosis may be made by noting whether the inflammation follows or does not follow the course of a vein.

As before stated, the exuded materials and the tissue in which the inflam-

matory products lie soon degenerate into pus. Sometimes the purulent formation occurs in isolated masses along the course of the vein, but generally it is continuous up and down the inflamed tract. If nature has closed the broken-down veins, as is usually the case, little or none of the products of disintegration enter the circulation, and the constitutional symptoms, though somewhat graver than in other forms of cellulitis, will have no special significance, consisting merely of an increase in the temperature of the body of from one to three or four degrees, a pulse varying from ninety to one hundred and ten or one hundred and fifteen, loss of appetite, severe headache and lumbar pain, and a thickly furred tongue. If, however, the suppuration is extensive, and the venous channels permeable, decomposing materials may enter the system; then symptoms will be developed akin to those which arise in pyæmia—indeed, they are in many cases nothing more nor less than pyæmic symptoms—and the disease will be likely to terminate fatally.

Rigors in all such cases are well marked. The temperature rises rapidly to 105° F. or 107° F. The pulse becomes weaker, and more rapid and compressible, and the face assumes an anxious expression; the tongue is dry and coated with a brown fur, and in the worst cases sordes form on the teeth early in the disease. In such cases we may expect a fatal termination.

Treatment.—In peri-venous cellulitis, even more than in the other forms of cellular inflammation, early incisions and the thorough cleansing of the tissues with carbolized water are of the greatest value in cutting short the disease, and in limiting the suppurative process. It is not advisable to wait until pus forms before cutting into the inflamed tissue on one side or other of the veins. The persistent use of carbolized water and charcoal poultices will do away with all danger of blood-poisoning from purulent formations. Some recommend the application of leeches over the inflamed vein, and cathartic medicines at the outset of the disease. In conjunction with hot applications they are often beneficial, and they may be tried when the patient dreads the knife. Tincture of iodine is also of some service; it may be applied with a camel's-hair pencil morning and evening over the inflamed surface. Ointments of mercury, belladonna, and opium are also employed.

Quinine and stimulants should not be omitted in the treatment. The stimulants may be best administered with milk in the form of "milk-punch," or with eggs beaten up as "eggnog." In all cases, nutritive materials should be administered with the stimulants, and the quantity administered should be regulated by the condition of the patient's stomach. If the stomach will not bear the combination of milk and stimulants, a goblet should be partly filled with small pieces of ice and a tablespoonful of brandy; a little Seltzer water added to this will make a very acceptable drink, which, in moderate quantities, is usually tolerated by an irritable stomach. The sulphide of calcium has been recommended to diminish the amount of suppuration. It is apt to disorder the stomach. Carbonate of ammonium in ten-grain doses is said to prevent the formation of coagula in the inflamed veins. I have given it as a diffusible stimulant in cases where great depression existed, and have obtained good results; but its reputed value in preventing the formation of clots is open to question.

PERI-ARTHRITIC CELLULITIS is an inflammation of the cellular tissue around the joints. The disease is of frequent occurrence in scrofulous children, though it is not uncommon in delicate adults. The most frequent causes are injuries, exposure to cold, and extension of inflammation from a diseased bone or joint. The pathological changes are similar to those already described under the head of diffused cellulitis.

Peri-arthritis cellulitis exhibits a preference for the cellular tissue over the knee and shoulder-joints. It commences with soreness about the joints, especially noticeable on movement of the limb. The pain on pressure extends beyond the locality of the joint. There may or may not be redness of the integument, but there are always the same tension and hardness which are found in other forms of cellulitis.

The disease is readily diagnosed from inflammation in the interior of the joint. In peri-arthritis cellulitis the swelling is continuous over the joint, and covers up the bony prominences around it. The swelling over the articulation is evenly distributed, and is not found in excess where the synovial membrane is uncovered by ligaments, as is the case in synovitis. There is no fluctuation in cellulitis until pus forms, and then it is not confined to the limits of the joint, while there is usually distinct fluctuation in synovitis. The joint surfaces may be forcibly approximated in cellulitis without occasioning any pain, while in inflammation of the joint there is usually considerable pain. The pain on pressure, in synovitis, is intense when the fingers press directly on the inflamed membrane, between the ligaments. In peri-arthritis cellulitis the pain is diffused over the whole surface. In cellulitis there is a feeling of hardness in the tumor, altogether absent in synovitis.

Treatment.—The limb involved should be kept motionless by the application of a well-padded splint, and hot applications should be made as previously directed. Indeed, the whole system of treatment recommended in simple diffused cellulitis is applicable here also, with this difference: great care must be exercised in making the incisions so as not to wound the structures entering into the formation of the joint.

ISCHIO-RECTAL CELLULITIS is an inflammation of the mass of cellular tissue situated between the anus and the tuberosity of the ischium. It is usually an acute disease, and is liable to occur at any age from local exposure to cold, such as sitting on the ice after skating, or on stone steps or stone pavements. It occurs also from traumatism, and from the extension of ulceration through the gut into the cellular tissue, and the subsequent entrance, through the ulcer, of irritating materials from the rectum.

The disease generally commences with acute pain on the affected side near the anus, extending up the rectum or down the thigh; the pain is aggravated by pressure from the outside, or by pressure of the finger in the rectum. There is considerable swelling over the fossa, which is also perceptible by a digital examination of the rectum. As the disease advances, the inflammatory swelling becomes hard and prominent; there is a frequent desire to go to stool, owing to the presence of inflammatory exudation on the rectal wall, which causes a sensation similar to that produced by the presence of feces. The formation of pus is made known by chilly sensations and rigors. The pus burrows where there is least resistance, and in this locality the least resistance is in an upward direction. The pus burrows underneath the levator ani muscle, upwards and around the rectum. It may by its presence produce necrosis of a portion of the wall of the rectum, and establish a fistulous communication to and through the integument. The pus may make its exit externally an inch or an inch and a half from the anus, and somewhat posterior to it, or it may open over the tuberosity of the ischium, or on the inner side of the thigh, or in the perineum.

Treatment.—As the great danger in ischio-rectal cellulitis is in the formation of a fistulous communication with the rectum, the efforts of the surgeon should be directed to the one end of cutting short the inflammation and preventing the burrowing of pus. If the patient is seen at the beginning of the disease, a brisk saline purgative should be given; when the bowels have

been freely moved, if the patient is strong enough to bear the loss of blood, half a dozen leeches may be applied over the inflamed part, and free bleeding promoted by hot fomentations. Twenty or thirty grains of quinine should be given at the same time, in one dose, or in divided doses within two or three hours. If the pain and swelling continue, a deep incision should be made without delay into the inflamed tissue of the fossa, whether pus has or has not formed. If the disease has existed three or four days before the attention of the surgeon is called to it, no time should be wasted with leeches or poultices, but an incision should be made large enough to prevent all burrowing of pus in an upward direction. If the incision is made sufficiently early, a fistula in ano will not occur. Even in cases where the cellulitis is the result of ulceration of the bowel and the subsequent escape of fecal matter into the cellular tissue, an early incision will limit the destruction of tissue around the anus and rectum. When the incision is made, charcoal poultices are to be applied for two or three days, or while there is a free purulent discharge externally. Every time that the poultice is changed, the wound should be washed with carbolized water or other disinfecting material. When the poultices are discontinued, the carbolized water dressing (two per cent. solution) will generally be sufficient to keep the wound clean, and to promote the growth of granulations.

As the wound made by the surgeon is at least an inch in depth, it will be necessary to pack it from the bottom after each washing, with charpie wet with carbolized water, carbolized oil, or balsam of Peru. When the granulations are full and flabby, as they often are in this situation, the solution of chloral hydrate or potassium permanganate may be sometimes advantageously substituted for those previously mentioned.

In all cases where the system is depressed, tonics and cod liver-oil are very useful adjuvants in the treatment.

If a communication between the rectum and the external integument has been established, the whole fistulous tract should be laid open without delay. It is better to make one operation of the whole, than to wait two or three weeks or months, as is usually done, for the cellulitis to subside, and then to open fistulous tracts. The prompt and efficient opening of the whole fistula will shorten the period of confinement to bed, and diminish the sufferings of the patient.

PERI-URETHRAL CELLULITIS may arise from injuries or operations on the urethra or perineum. There are two forms of this disease, viz., one in which the inflammation occurs in small isolated patches in the penile portion of the urethra; and a second, in which it forms one continuous mass between the layers of the triangular ligament behind the bulb. In the former, the inflammation occupies, in the majority of cases, the neighborhood of the glans penis. It may arise from contusion or from straining during prolonged and violent sexual intercourse, or from laceration of urethral fibres during an attack of chordee; or it may follow an attack of gonorrhœa when there is no history of injury during copulation. This, however, does not preclude the possibility of injury having occurred. I am inclined to the opinion that all cases, whether occurring with or without gonorrhœa—except those following chordee—are the result of contusion in sexual intercourse.

The symptoms are obscure at first, especially if the cellulitis is accompanied by gonorrhœa, because the scalding which occurs in the latter during micturition, and the soreness during the intervals of micturition, obscure the circumscribed pain of the former affection. The first abnormal symptom which generally attracts the attention of the patient is the formation of a small, hard mass close to the urethra, ranging in size from the bulk of a pea to that of a

hazel-nut. It is painful on pressure, and there is also considerable pain during erection and micturition—the pain being centred over the hardened spot previously mentioned. Occasionally the cellulitis extends up and down the canal in the median line for an inch or two, the swelling occupying the median line, and being symmetrical in its whole length. Suppuration is apt to occur in the majority of cases, though not as often as in cellulitis between the layers of the triangular ligament. In many instances a lump of inflammatory exudation remains from one to three months, and is finally absorbed without doing any special injury to the urethral canal.

The second form of peri-urethral cellulitis is confined to the perineal portion of the urethra, between the layers of the triangular ligament. It often originates in the cellular tissue around Cowper's glands, but it may start further back. The inflammation is much more extensive than in the first variety, on account of the greater amount of cellular tissue involved, and its looser connections; and the disease generally ends in suppuration. It is sometimes the result of blows or falls on the perineum. It may also be caused by a small point of follicular ulceration behind a stricture. The ulcer gradually extends, piercing the urethral wall; as it progresses, its internal orifice becomes occluded by plastic exudation, while the inflammation spreads rapidly in the cellular tissue between the layers of fascia.

The symptoms, though well marked, are often attributed to other causes. There is pain in the perineum, more severe during micturition than at any other time; it may occupy one side or the other of the median line, and it extends to the inner side of the thigh and down to the anus. As in other forms of cellulitis, it is aggravated by pressure. As the disease progresses, a hard, well-defined swelling is found, generally on the right side of the median line; this gradually extends until the perineum is equally distended on each side of the raphe, and a well-marked tumor formed. In some cases the exudation is in sufficient quantity to close the urethral canal and cause retention of urine; or, if the pressure does not close the canal, it may cause ulceration of the urethra, and give exit to the pus in that way. This is a common occurrence, especially in neglected cases, and the inevitable result is a urethral fistula, which, however, generally closes without any further surgical interference than is mentioned hereafter.

Treatment.—In both forms of peri-urethral cellulitis, the bowels should be kept free with mild laxatives. A mixture consisting of an ounce each of Epsom salts and cream of tartar to one pint of water, may be given in two-ounce doses every morning; if the patient is very plethoric, a wineglassful may be given the first day every hour, until five or six doses have been taken; afterwards, the two-ounce dose in the morning will be all that is necessary. When the cellulitis is in the penile portion of the urethra, the parts may be bathed frequently in cold water; after each bath the penis should be wrapped in several folds of wet linen, or covered with a wet towel, with a layer of oiled silk tied on over all. Cold sitz-baths at night are also beneficial. In addition to the cold-water treatment, the integument over the inflamed spot may be painted daily with tincture of iodine, or with a saturated solution of nitrate of silver, until the epithelium is destroyed and the skin somewhat sore; these applications may then be postponed for a few days, to be resumed when the skin has healed. Oleate of mercury is also an excellent local remedy to promote absorption; it too may be rubbed in daily until the skin becomes sore.

Iodide of potassium is of service in cases where the stomach tolerates its use; it may be advantageously combined with tonics.

As before remarked, penile, peri-urethral cellulitis does not result as frequently in suppuration as the perineal variety. With proper care, the knife

is seldom called for. Incisions should not be made, moreover, for obvious reasons, in these cases, until pus forms and is plainly perceptible; then a small air incision as is compatible with free drainage should be made, and the abscess washed out in the usual manner. The cold-water dressings may be continued throughout the whole course of the disease.

The treatment of the perineal variety of peri-urethral cellulitis is the same as advised in ischio-rectal cellulitis, viz., leeches and cathartics to cut short the inflammation, and early incisions through the dense fascia into the inflammatory swelling, in order to insure the escape of pus externally and save the urethra from perforation. Half a dozen leeches should be applied over the perineum, followed by hot applications, to promote bleeding and absorption. If the patient is anæmic, both leeches and cathartics may be dispensed with. The incision should be made over the centre of the swelling, whether that centre occupies the median line of the perineum, or is situated at some distance from it. If the urethral wall has already been perforated, it is well to find the opening, and incise the urethra above and below the perforation. To incise the urethra in the median line at a distance from the false passage is not good surgery. By including the ulcerated opening in the incision, a much more rapid cure will be effected, and the continuance of a urethral fistula probably prevented. If any strictures exist in the canal, they should be cut or dilated. The antiseptic washes previously described are also indicated here under all circumstances.

PERI-PHALANGEAL CELLULITIS, sometimes called *paronychia*, *felon*, and *whitlow*, is an exceedingly common form of inflammation. It may be located in the subcutaneous cellular tissue, in the fascia that retains the tendons in position, or in the cellular tissue connected with the periosteum and bone. It is probable that many of the more severe forms of the disease originate in the periosteum. Occasionally the inflammation is confined to the cellular tissue around the margin of the nail, and in common parlance is known as a "run-around." This is the mildest form of peri-phalangeal cellulitis, and is rarely followed by serious injury to the bone or ligamentous structures. The principal cause of peri-phalangeal cellulitis is injury of the affected member, when the blood of the patient is impoverished from poor diet, bad air, dissipation, etc. It usually commences on the palmar aspect of the finger, with a sharp or intense pain, and slight swelling of the pulp of the finger. The pain increases in intensity, and the swelling extends to the sides and back of the phalanx. The whole surface of the inflamed part becomes exceedingly tense, hard, and painful on pressure. After the third or fourth day the pain assumes a throbbing character, and is almost unbearable. The patient can neither rest nor sleep; there is very little febrile excitement, the temperature seldom rising more than a degree, and the pulse often remaining normal throughout the disease. Pus forms in five or six days from the commencement of the attack; if allowed to burrow under the tight fibrous bands which cross the tendons, it soon destroys the periosteum and leads to necrosis of the bone. In virulent cases the morbid process rapidly extends, involving successively the cellular tissue of the hand and arm, destroying such an amount of tissue as to permanently impair the usefulness of the whole limb, and perhaps causing a fatal termination. Very many cases of peri-phalangeal cellulitis result in caries or necrosis of the phalanx, but such results generally arise from neglect on the part of the patient or surgeon.

Treatment.—For a day or two, a hot linseed-meal poultice, changed frequently, does excellent service. If the patient is seen three or four days subsequent to the beginning of the inflammation, the first thing to be done is to cut down through all the inflamed tissues, on the palmar aspect, to the bone. A simple

incision through the integument will not answer, not even in those cases where the disease seems to be limited to the subcutaneous cellular tissue. In all cases the bone should be touched by the edge of the knife. By this means all the tension made by the exudates and proliferation of cells will be relieved. The intense pain will be removed in a few hours, the pus that forms will find a ready outlet, and the finger will be saved from all distressing sequelæ.

It is also good practice to make a free incision in old cases where the pus has already made an exit for itself externally; this procedure hastens a favorable termination, and limits the destruction of bone, which, in such a case, has probably already commenced.

All incisions should be followed by hot poultices, and by thorough cleansing with antiseptic solutions when the wound begins to granulate. Gentle pressure should be made around the phalanx by means of adhesive plaster or a finger bandage. This should be tight enough to close somewhat the gap on the finger, but not tight enough to interfere with the circulation.

PERI-CÆCAL CELLULITIS (*Peri-typhlitis*).—This disease is of much more frequent occurrence than was formerly supposed. Modern methods of investigation have rendered its diagnosis a matter of certainty, and placed its treatment on a practical and scientific basis. In the majority of cases the disease results from the impaction of some foreign body in the appendix vermiformis or walls of the cæcum; ulceration ensues, and an opening is made in the wall, through which the foreign body makes its way into the cellular tissue outside. Fæcal matter is apt to pass through also. In such cases the inflammation is much more severe and dangerous than when caused simply by the presence of a cherry stone, peach pit, or other foreign material of a similar character.

Peri-cæcal cellulitis nearly always terminates in suppuration. A second attack is not as apt to be followed by suppuration, as the first. Second attacks do not arise, as a rule, from perforation of the gut, but are due to slight injuries of the organized mass of lymph which resulted from the first inflammation.

Symptoms.—In peri-cæcal cellulitis the symptoms are not at first very well defined. Usually the patient complains for several days of colicky pains in the bowels, not confined to the vicinity of the cæcum, but shooting across the lower part of the abdomen. There are also disordered digestion, loss of appetite, and flatulence. The patient is restless and uneasy, and at night is feverish and unable to sleep; the pain is aggravated while at stool, but subsequently passes away, leaving the patient for a few hours comparatively comfortable, and seemingly free from any serious affection. If pressure is made during this interval, it will give rise to more or less pain. Very soon all the symptoms return with increased activity, and in the course of a week from the commencement of the disease, careful palpation over the involved organs will show a swelling, not well defined in outline, hard and painful to the touch, and deep-seated. Steady pressure over it causes starting pains in other portions of the abdomen. The febrile symptoms at this time are also well marked. The temperature varies from 101° F. to 103° F., seldom rising higher unless some complication is present, and the pulse ranges from 105 to 120. The tongue is coated and the face somewhat anxious. The stomach is irritable, and in some cases little or no nourishment can be retained. Constipation alternates with diarrhœa throughout the disease. The bladder is irritable, and there are frequent calls to urinate, each urination being accompanied by more or less pain. In a day or two longer all the symptoms are aggravated, the lesion is perceptible on inspection in the iliac region, and is

very painful and tender to the touch. When the finger is introduced into the rectum, a hard, well-defined swelling will be felt high up in the right side, and posteriorly.

Chills and rigors, as in other cases, indicate the formation of pus, and these signs of purulent formation may be accompanied by a perceptible and rapid increase in the size of the tumor, without fluctuation. Indeed it is almost impossible to detect fluctuation on account of the thickness of the walls which inclose the pus, and the additional covering made by the abdominal muscles.

If left to nature, the pus may make its exit through the rectum, or into the colon high up, or it may rupture into the bladder or peritoneal cavity. It generally makes an opening in the wall of the rectum. This is the most favorable road that the matter can take, such cases often terminating in recovery. If the abscess ruptures into the peritoneal cavity, the accident may be recognized by the occurrence of a sharp pain at the seat of rupture, tympanites, vomiting, and collapse. It is always fatal. If the pus perforates the rectum, there will be a purulent discharge per anum, accompanied by a sudden diminution in the size of the tumor. When the bladder is perforated, which is a rare occurrence, pus in considerable quantity will be distinguished in the urine.

Treatment.—If a diagnosis is made early in the case, castor oil should be given in quantities sufficient to produce several large evacuations from the bowels. The colon near the seat of inflammation often contains hard masses of fecal matter, which aggravate by pressure all the unfavorable symptoms. Free catharsis, therefore, is in nearly all cases necessary. An ice-bag may then be applied to the part, and a large dose of quinine given internally. Should the inflammatory symptoms continue in spite of these measures, and the swelling be well defined in the iliac region, an incision should be made without any further delay. As the purulent matter is altogether external to the peritoneum, and as the latter is not involved in the operation, there is little or no danger attending it.

The incision should be made over the highest part and centre of the tumor, parallel with Poupart's ligament. It ought not to exceed three inches in length, on account of the tendency to hernial protrusion when the abdominal walls are weakened by larger cuts. From two to three inches is sufficient for all purposes. When the integument and aponeurosis of the external oblique muscle have been divided, it will facilitate matters if a hypodermic syringe is introduced into the tumor, to determine the exact locality of the pus. If the syringe is inserted before the parts mentioned have been cut, it will be hard to find the purulent collection. When the syringe is withdrawn, the cutting may proceed in the same direction as the external incision, and of a similar length, until the cavity of the abscess is reached. The discharged pus has usually a strong fecal odor, and an examination of it may determine the nature of the foreign body which excited the inflammation.

The abscess is to be thoroughly cleansed with a 1-40 solution of carbolic acid, a drainage-tube inserted, and the edges of the wound drawn together with a few catgut sutures. In some instances it is necessary to leave the wound open for several days in order to keep it free from all purulent or fecal collections, or to pack it from the bottom with carbolized charpie after every washing.

A full dose of opium may be administered after the operation, and quinine in moderate doses may be given daily until the wound has completely united.

In cases where the peritoneum has been opened, I believe it would be good practice to cut down on the abscess, open the peritoneal cavity, and

wash it thoroughly with carbolized water. The operation certainly would not hasten a fatal issue, and the patient would, in such a case, have no chance without it.

ORBITAL CELLULITIS is not a common form of disease. It is usually the result of external violence, involving more or less the eyeball and the neighboring tissues. Not infrequently it follows convalescence from low fevers or erysipelas.

The *symptoms* are obscure at the inception of the disease, consisting simply of deep-seated pain in the orbit, somewhat throbbing in character, with redness and swelling of the conjunctiva and lids. Subsequently the eyeball is pushed out by the exudation behind, and becomes very prominent and, to a great extent, immovable. Fluctuation may be ascertained by lifting the upper lid, and examining the distended conjunctiva.

The *treatment* consists in placing warm fomentations over the eye, applying leeches to the temples, and administering a mild cathartic internally. Most surgeons agree that no attempt should be made to open the abscess until a very distinct pointing takes place near the surface. Then it is well to puncture and clear out the cavity. Tonics and stimulants are indicated in the majority of cases.

MALIGNANT CELLULITIS.

This disease is usually the result of the introduction into the circulation of an animal poison, which excites a violent and destructive inflammatory action in the cellular tissue and skin, and superinduces constitutional disturbances which generally end in death.

There are two varieties of malignant cellulitis: the first arising from the introduction of dead or decomposing material by means of a dissecting wound or a simple abrasion; the second resulting from the insertion of a peculiar virus through a wound made by the teeth or fangs of a reptile, or the sting of an insect.

The persons affected by the *first* form of malignant cellulitis are generally students of medicine, and physicians who make a special study of morbid anatomy in the "dead-house" or dissecting-room. But it is not invariably confined to this class. Many persons acquire the disease from handling dead animals or putrid meats, the decomposing material entering the circulation through an old cut or abrasion of some sort on the fingers or hands. I have seen cases where the entrance of the poison was effected through the presence of an ordinary "hang-nail." Surgeons also may contract the disease during an operation, by handling a gangrenous limb, or unclean and gangrenous ulcers. The persons affected may be unconscious of any injury, or of having at any time been the subject of local poisoning. Within twenty-four hours from the time of puncture with the dissecting-knife or jagged end of a bone, the border of the wound assumes a dusky red hue, and becomes considerably swollen; the epidermis is raised by a brownish serum, which in a few hours becomes opaque and purulent. A sharp, burning pain occupies the seat of the wound, and severe shooting pains extend up the arm to the shoulder. Red lines are seen radiating from the wound up as high as the axilla, indicating the presence of lymphangitis. The lymphatic glands in the axilla become enlarged and painful. At this time the whole limb is greatly swollen; it is infiltrated throughout by serous lymph and pus, and irregular masses of suppuration form in various parts, including the lymphatic glands. Sloughing of the

integument over these parts soon follows, and through the openings large quantities of fetid pus are discharged.

Lymphangitis and lymphadenitis are marked features in nearly all forms of malignant cellulitis. The lymphatics as well as the veins carry the poison. The poisonous matter inflames the lining membrane of these channels, and may produce coagulation of their contents. In some cases it is intercepted by the lymph glands, and produces an inflammation which rapidly destroys them.

From the onset of the disease, the constitutional symptoms are well marked and violent. The poisoning of the blood is evidenced by chills and rigors, which are rarely repeated after the first day—the disease in this respect differing from ordinary pyæmia, which is usually attended by chills during the whole course of the affection. The chills are followed by high fever, the temperature rapidly rising to 104° F. or 106° F., or even higher. There is often frontal and lumbar pain, and pain in the limbs also. The eyes are suffused, the expression of the face is one of deep anxiety, and the tongue is dry and coated with a brown fur. Billroth says that the tongue is sometimes as hard as wood. In the worst cases there is delirium. The urine is scanty and high-colored, and contains albumen. The patient sinks into a typhoid condition, is apathetic, and unless possessed of sufficient vitality to overcome the effects of the poison, may succumb to the disease in from three to ten days from its commencement.

Although a large majority of patients afflicted with malignant cellulitis die, there are cases where the local inflammation is the principal element, the lymphatic glands having intercepted most of the poison. In such cases the constitutional as well as the local symptoms are much milder, though the inflammation in the cellular tissue of the diseased limb passes through all the phases previously described, and the patient recovers with the loss of a finger, or perhaps of the hand and forearm as well.

On post-mortem examination, the liver will be found softened and filled with blood. The spleen is very friable and enlarged, and infarcts may be found in it. There are no collections of pus, such as are found in pyæmia.

Treatment.—As soon as the wound is made, it should be washed thoroughly and sucked by the patient. A little nitric acid or pure carbolic acid may then be applied, so as to cover every part of the wound and neighboring integument, and the wounded limb should be suspended in a sling and covered with charcoal poultices. A grain or two of opium and from twenty to thirty grains of quinine should be given as soon as possible after the injury. When the cellulitis is fully developed—that is to say, when the wounded extremity is swollen and painful, and red lines have begun to show on the hand and forearm—a free incision should be made through the wound down to the bone, extending at least half an inch above and below. When suppuration occurs, other incisions also should be made in various parts of the forearm and arm, through the skin and subcutaneous cellular tissue to the muscles, so as to afford exit to the pus and other inflammatory formations, and thus diminish the tension in the swollen limb. The charcoal poultices previously recommended are still to be used, enveloping the limb from the shoulder to the tips of the fingers; the limb is then placed on a pillow, and opium and quinine again administered. If the charcoal cannot be had for the poultices, clay, linseed meal, or bran will be found to answer well as substitutes.

Stimulants may be given *ad libitum*. If the stomach fails to retain them they may be injected, well diluted, into the rectum.

The *second* form of malignant cellulitis arises from wounds or bites of the rattlesnake, cobra di capello, tarantula, scorpion, etc., and other reptiles and

insects. In these cases, the constitutional disturbances are of such magnitude that the cellulitis is of comparatively little consequence. There are cases, however, in which the inflammation in the wounded limb endangers the life of the patient independently of the general blood-poisoning, and in which recovery may take place under judicious treatment. The absorption of the virus and the succeeding local inflammation take place more rapidly than in the preceding variety. Indeed, the marked changes, both local and constitutional, may run their course in two or three hours, terminating the life of the patient. In the milder forms of the disease, the wounded limb is infiltrated rapidly with bloody serum and lymph, and rapidly increases in size. The integument has a mottled and puffy appearance, and blebs of bloody serum form under the epidermis. The inflammation may extend to the tissues of the trunk on the wounded side. If the disease is protracted for three or four days, purulent masses form all through the diseased limb, as in the previously described form of the disease; or gangrene may set in and destroy the life of the patient, after the constitutional effects of the poison have been overcome by the proper antidotes. (See *Poisoned Wounds*, Vol. II., page 85.) The *treatment* consists in preventing the poison from entering the circulation by means of incisions, the application of ligatures above the wounded part, cupping the wound, cauterization, and hypodermic injections of carbolic acid at various points up and down the limb. Free incisions to lessen the tension in the limb, and the application of charcoal poultices mixed with sweet oil to the whole extremity, are efficient means of lessening the inflammation. Carbonate of ammonium and whiskey may be given internally in large quantities. Ammonia is sometimes introduced hypodermically.

MYXŒDEMA.

MYXŒDEMA, otherwise known as *Hypertrophy of the Cellular Tissue*, *Cretinoid Disease*, *Mucoid Degeneration of the Cellular Tissue*, *Polysarcia*, etc., is a rare affection first described by Sir William Gull, and subsequently by Dr. Ord and M. Olivier. It was at one time supposed to be simply an increase in the adipose tissue, hence the term *polysarcia*. There is a large increase in the fatty elements of the body, but the principal changes are found in the component elements of the cellular tissue.

The characteristic *symptoms* of the disease, as given by Gull, are as follows: "There is general enlargement of the whole body, especially marked on the face, which enlarges transversely, and becomes round. The skin becomes soft and delicate, and acquires a sort of transparency analogous to that of porcelain; the cheeks are rose-colored. The subcutaneous cellular tissue about the orbit becomes loosened, that of the back of the neck, and of the throat, thick and folded. The distance between the eyes seems large, and the root of the nose depressed. The lips, large and thickened, are of a purplish-red color; the alæ of the nose are hypertrophied. The face is modified in its shape, and assumes a bloated appearance, at the same time preserving a soft and rather agreeable look. The tongue becomes large and thick, the voice guttural, and pronunciation is impeded by the deformed tongue. The same changes appear on the hands, and they become infiltrated and massive. As the disease progresses the patient becomes listless, and capable of less and less exertion. The intelligence is dulled, and the habitual indifference is but rarely interrupted by periods of irritation. There is, properly speaking, no mental trouble. The trunk and inferior extremities become loaded with fat, giving the appearance of general œdema."

The disease lasts from ten to fifteen years, and its termination is characte-

rized, according to Dr. Ord, by a remarkable decrease in the animal heat. In one recorded case, the temperature was only 77° F.

Under the microscope, all the elements of the areolar tissue, including the fibres, cells, and "interstitial mucous substance," are very much increased. These changes are not confined to the integument or subcutaneous cellular tissue, but are also found in the arteries and internal organs.

Treatment.—Iodine, iron, and cod-liver oil have been recommended, and tried with little or no benefit. On theoretical grounds I should recommend Russian baths, frequent friction of the surface, electricity, and very active exercise in the open air.

ATROPHY OF THE CELLULAR TISSUE.

Atrophy of the cellular tissue, though sometimes combined with progressive muscular atrophy, generally occurs as an independent disease. In the greater number of cases it arises from the prolonged irritation of a nerve or nerves. It occurs most frequently in the face and lower extremities. Brown-Séquard mentions a case which came under his notice in Boston, where atrophy of one side of the face was preceded by convulsive movements of the muscles on the affected side; the disease was ascribed to irritation of the dental nerves. Atrophy of the cellular tissue on one side of the face has also been caused by irritation of the facial nerve. Schott and Romberg have called this variety of the disease *facial trophoneurosis*. It is as rare as other forms of the affection.

It is probable that the wasting of a limb which has been kept for a length of time on splints, or which has been prevented by disease from doing its work, arises from atrophy of the cellular tissue as well as from atrophy of the muscles and absorption of fat.

Treatment.—If the cause of the disease can be reached, it must be removed if possible; the diseased part should be frequently sprayed with cold water, and rubbed dry, and the induced current applied daily to the nerves until some benefit is obtained. Nux vomica and cod-liver oil are useful as internal remedies.

PARASITES OF THE CELLULAR TISSUE.

The parasites usually found in the subcutaneous cellular tissue are the *Cysticercus cellulosa*, the *Guinea worm*, known also as the *Dracunculus* and *Filaria Medinensis*, and the *Sand flea*, or *Pulex penetrans*.

CYSTICERCUS CELLULOSA.—This parasite is found usually in the cellular tissue between the muscles; less frequently it occupies the meshes of the subcutaneous cellular tissue. It is occasionally seen in the delicate areolar tissue, under the conjunctiva, in the aqueous and vitreous humors, and also in some of the internal organs. It is a species of hydatid, an undeveloped *tænia solium*. It consists of a small vesicle, about two lines in diameter, in which the embryonic worm is supported. It is not apt to give any particular manifestation of its presence while in the subcutaneous or inter-muscular cellular tissues. Even in the delicate sub-conjunctival layer, it merely excites slight conjunctivitis. It is only when the aqueous and vitreous humors, or some of the internal organs, are invaded, that any danger arises from its presence.

FILARIA MEDINENSIS.—The *Filaria Medinensis*, or common Guinea worm, infests countries south of the equator. Rarely is it seen in temperate climes,

and then only when transported in the tissues of some traveller from the southern regions.

In its undeveloped state the Guinea worm measures $\frac{1}{40}$ of an inch in diameter. At this period of its existence it penetrates the integument through the sudoriparous glands or their follicles, and finds a lodgment in the cellular tissue. Then follows a period of "latent existence" (Busk), varying from six to eighteen months, during which time the parasite gives little or no evidence of its existence. At the end of that period it measures from two to ten feet in length when uncoiled. It now makes an effort to reach the external world, and in doing so excites the circumscribed inflammation in the integument and subcutaneous cellular tissue that indicates its presence. A minute elevation of the skin occurs just over the residence of the parasite. This spot has a reddish color, itches, and when pressed is painful. The swelling soon becomes harder and redder, looking very much like a small boil; pus forms at its highest point, and the head of the worm protrudes. Ulceration sets in around this point, and may extend some distance into the surrounding tissue; and there may also be some deep-seated spots of suppuration.

When the patient has a large number of these worms in various stages of mature development, the local inflammation is accompanied by some pain in the affected extremities and considerable febrile excitement.

The *treatment* consists in cutting down carefully through the inflamed spot, and extracting the parasite with a forceps which grasps the centre of its body. Busk recommends the slow removal of the parasite by winding the body slowly around a piece of pipe-stem, bougie, or twig, bringing out each day a portion until the sac is completely emptied.

PULEX PENETRANS.—The *sand flea*, *jigger*, or *pulex penetrans* is another troublesome parasite peculiar to southern climates. The male is harmless. The female does not attempt to enter the skin until she becomes impregnated. Then she seeks a nidus in the subcutaneous cellular tissue and skin, where the process of incubation can go on without hindrance.

The parasite passes in through the integument under the nails, between the toes, and at other parts of the feet. As soon as the ova distend the abdomen of the flea, a small whitish swelling appears (Busk) which grows rapidly, and excites an inflammation which is apt to lead to the formation of intractable ulcers.

The *treatment* consists in enlarging the opening through which the insect entered, and picking it out with the point of a needle. Afterwards the cavity should be frequently washed with a strong solution of carbolic acid, turpentine, or tobacco juice.

INJURIES AND DISEASES OF BURSAE.

BY

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THE large number of bursæ found in the human body, the liability of their diseases to be confounded with more serious maladies, and the fact that most, if not all, cases of peri-arthritis suppuration can be traced to a precedent inflammation of one of these sacs, demand a more extended notice of their affections than is usual in most surgical works.

In addition to those usually described by anatomists, adventitious bursæ are apt to be developed wherever projecting portions of the skeleton, but thinly covered by soft parts, are subject to long-continued pressure and friction. These adventitious bursæ usually form over abnormal projections of the skeleton, such as are seen in gibbosities of the spinal column, or on the outer side of the foot in talipes varus, where the structure of the soft tissues is such as is not calculated to bear pressure without injury, unless some elastic water-pad, such as a bursa, is interposed between the integument and the subjacent hard parts. Enlarged bursæ have been mistaken for aneurisms, and many of them communicate with the neighboring joints. On this account, their injury, whether by accident or by the surgeon's knife, has been sometimes followed by destruction of the functions of the limb, or even by loss of the patient's life.

DEVELOPMENT AND ANATOMICAL RELATIONS OF BURSAE.

A careful study of the mode of development of bursæ, and of their anatomical relations, is of prime importance, and will render clear certain facts in connection with their diseases, otherwise difficult to understand. Anatomists are in the habit of describing two varieties of bursæ—the *bursæ mucosæ* and the *bursæ synoviales*—the latter being ligamentous sheaths lined with a thin secreting membrane, in which the tendons play, while the former are simple serous sacs, which may or may not be in relation with tendons. Vascular fringes are present in certain of the so-called bursæ mucosæ, but there is no real histological difference between the two varieties.

The diseases of the bursæ mucosæ will chiefly occupy our attention, although those of certain sacs which have been classed by some anatomists with the synovial bursæ will be described. Bursæ, from a clinical standpoint, should be again subdivided into two classes, (1) the subcutaneous, and (2) those in relation with the more deeply situated tendons, and, in consequence, often connected with joints. This is not a nice anatomical distinction, but one of practical import, since treatment which would be safe and appropriate to bursæ of the former variety might, and often does, end most disastrously

when applied to those of the latter. This practical point, resulting from the differing anatomical relations of bursæ, must never be lost sight of in deciding what is proper to be done in any given case.

All bursæ are closed serous sacs, which are, as I shall next show, developed from the cellular tissue. This latter consists of innumerable decussating fasciculi of connective tissue, continuous with the skin, periosteum, aponeuroses, etc. From the interweaving of the fasciculi result minute spaces, in which there normally exists a serous or lymph-like fluid. Large flat nucleo-nucleolated cells are seen applied along the fasciculi, which resemble, and are practically identical with, the endothelial cells of all serous membranes. Owing to the mechanical arrangement of the connective-tissue bundles, they move upon one another as do the opposing surfaces of any serous cavity, such as the pleura. These movements are facilitated by the presence of the serous fluid before adverted to. All that is now necessary for the formation of either a normal or abnormal bursa, is a local accumulation of the normally present fluid, which, by pressing aside the connective-tissue bundles, will condense them into a wall lined by a more or less imperfect layer of connective tissue, that is, endothelial cells. Such cavities will be traversed—as bursæ frequently are—by imperfect partitions, or perhaps merely isolated bundles of fibrous tissue. If, as pointed out by Cornil and Ranvier, the site of a hypodermic injection of serum be examined, precisely what I have just described will be seen, neither macroscopically nor microscopically different in any important detail from the appearance presented by a normal bursa. If it be asked what produces the primary accumulation of fluid, I answer, the normal movement of pressure and friction to which the parts are subjected. These produce a local congestion, resulting in the effusion of fluid; the congestion recurring, prevents its absorption; and it finally becomes permanent, and also changed in character. The continued traction on the imperfect partitions and bridles which traverse the cavity, results in their nutritive elongation or rupture, thus either permitting free communication between the different loculi, or throwing a number into one. Whether of intra-uterine—for some appear by the end of the third month—or of extra-uterine origin, I believe that the mechanism is the same for all varieties of bursæ.

When it is borne in mind that the normal interfascicular spaces of the connective tissue are in direct communication with the lymphatic vessels, it is clear that a bursa is nothing but a constant, larger lymph space. As a bursa is, then, an integral part of the connective tissue, there is no warrant that inflammation of one of these sacs will remain localized. On the contrary, a traumatic inflammation of the bursa, over the olecranon, for instance, not uncommonly results in an extensive cellulitis of the arm and forearm. On the other hand, a primary affection of the skin and subcutaneous cellular tissue may excite inflammation in a contiguous bursa. This lymphatic connection—the bursæ being, indeed, as has been seen, a part of the lymphatic system—readily accounts for the marked constitutional disturbance seen in acute inflammation of certain of the larger of these structures. To compare small things with great, the condition is similar to that seen in peritonitis, where, the peritoneal sac being practically nothing but an enormous lymph space, septic products are rapidly absorbed, and, by their sudden introduction into the blood-current, produce the well-known, profound constitutional impression observed in that disease.

These pathological facts should be kept constantly in mind, as they have an important bearing on treatment. The surgeon must also never forget that bursæ which are contiguous to joints, but do not communicate with them in the young, often do so in the adult.

BURSITIS.

CAUSATION; GENERAL CONSIDERATIONS.—Ordinary gout, plumbie gout,¹ syphilis, rheumatism, blood-poisoning, scurvy, and perhaps certain forms of Bright's disease, are undoubted predisposing and, in some cases, exciting causes of this malady. The failure to recognize these underlying conditions accounts for the obstinacy of certain cases under merely local treatment. Wounds, contusions, the recurring pressure and friction incident to certain occupations, excessive muscular exertion, sprains, etc., are among the more common exciting causes. In pronouncedly rheumatic or gouty persons, the most trivial use of parts, or even variations of temperature or errors in diet, will suffice to produce a recurrence, if not a primary attack, of bursitis. Bursal enlargements due to rheumatism or gout appear rapidly, and are apt to attack the deep-seated rather than the superficial bursa. The effusion may suddenly leave one bursa, and another may become distended; and again this enlargement may disappear, only for the disease to attack a third sac.

ACUTE BURSITIS.—After some traumatism, or perhaps only over-use of a part, a local, tense, more or less distinctly fluctuating swelling will appear, which is tender on pressure, and in certain instances the site of severe lancinating pain. The skin at first presents a circumscribed pink flush. This soon spreads to the adjacent integument, and if the inflammation increases—especially should suppuration occur—the skin becomes oedematous and of a dusky, livid appearance, when ulceration soon occurs. The constitutional reaction is often marked, with high temperature, headache—I have even seen delirium—furred tongue, and confined bowels. The effused fluid, containing floating masses of lymph, consists of serum, which may be of a reddish tinge from a slight admixture of blood. When the bursitis is the result of a blow, the effusion may consist largely of pure blood, which may remain fluid, or, after clotting, may undergo various changes. Acute bursitis terminates by resolution, suppuration, or sloughing. Rheumatism, gout, pyæmia, and plumbism are undoubtedly predisposing and sometimes exciting causes.

Treatment of Acute Bursitis.—When describing the treatment of the diseases of each bursa, any special indications presented by its nature or locality will be adverted to. At present, the general principles involved in the treatment of any acute bursitis will be considered. The prime essential—since, as we shall see, over-exercise frequently gives rise to effusions into the bursæ—is absolute rest of the limb, insured by the recumbent position, and the application of an appropriate splint. The condition of the bowels and digestion should be investigated, since, if a spreading cellulitis result, the vital powers may be taxed to their utmost. If a purgative be indicated, with a vigorous patient, a mild mercurial followed by a saline will be eminently appropriate. If the patient be in a depressed state of health, a mild laxative will suffice. A simple, bland, unirritating diet should be directed, and, if the patient be of a gouty constitution, something even like the old-fashioned antiphlogistic regimen will be not only appropriate, but imperatively demanded. Pain must be controlled by opium, best combined with diaphoretics. Gout or rheumatism, either demonstrated or suspected on good grounds, indicates the exhibition of appropriate remedies, such as salicylic acid, the salicylates, colchicum, alkalies, etc. In vigorous cases, when the inflammation runs high, free leeching is useful. The use of blood-letting should, however, be limited to the most severe forms of acute bursitis, when a spreading cellulitis of the

¹ Guy's Hosp. Rep., 3d s., vol. xv., 1870, p. 46.

whole extremity is impending, and can only be averted by such local depletion of the bloodvessels as will permit the circulation to go on, and thus prevent strangulation of the tissues. After the cessation of the bleeding, a bladder of pounded ice should be kept constantly applied, or cold evaporating applications, such as a spirit lotion, or lead-water and laudanum; or, in default of anything better, simple cold water may be used. If, in despite of all these measures, suppuration should occur, poultices should be substituted.

When pus has fully formed, it must be evacuated by some means. If the suppurating sac does not communicate with a joint, the knife—best with antiseptic precautions—should be made use of. On the other hand, when there is ground for thinking that the bursa opens into a contiguous joint, a careful aspiration under the spray must be the first resort. If, after repeated tappings, pus reaccumulates and will manifestly discharge itself, the abscess should be boldly laid open, but only under the strictest antiseptic precautions. Where such measures are impossible, owing to want of apparatus, “hyperdistension” with a two per cent. solution of carbolic acid, after Callender’s method, should be substituted. It is well to be certain that *pus*, not *serum*, is present, as incisions under the latter circumstances have proved fatal by favoring septic absorption.¹ Incisions into inflamed tissues, as Paget² has ably pointed out, should, when possible, be avoided, since they are exceedingly apt, as I have seen myself, to be followed by the development of phlegmonous erysipelas. The surgeon must, however, beware of allowing pus to remain confined in the bursa contiguous to joints, lest the sac rupture subcutaneously, and the pus set up a diffuse periartritic suppuration, or lest a similar disaster result simply from the inflammation spreading by contiguity of tissue, for want of a proper vent for the irritating matter. In a doubtful case, the aspirator or an exploring needle will either secure the safe removal of whatever is present, or show that the knife is not needed.

Should the suppuration be excessive, tonics, such as iron, quinia, or bark, ammonia, good food, and stimulants, must be exhibited. Erysipelas, including erysipelatous cellulitis, must be treated as if occurring from any other traumatism, by iron, opium, quinia, etc., and, if necessary, by appropriate incisions. Should sloughing occur, yeast or charcoal poultices should be applied, and when the surface cleans off, the sore, as well as the troublesome sinuses which occasionally result, must be treated on general principles. Sinuses when recent can often be made to heal by appropriate pads or compresses firmly applied. In the event of their failure, when the case becomes chronic, injections of some irritant, sufficiently concentrated to set up a degree of inflammation which will give rise to granulations, such as iodine or carbolic acid, should be tried. An oakum seton may also prove useful. Where no important parts intervene, the sinuses should be laid open with the knife or galvano-cautery. The latter instrument is the better, since the heated wire effectually destroys the indurated walls, so as to demand less care in the after-dressings to insure healing from the bottom.

SUBACUTE BURSTITIS.—The first symptom consists in a local tenderness on pressure, which produces a peculiar sense of crepitation beneath the fingers. This is due to a slight serous effusion, and can be detected before any local swelling occurs. In all other respects the symptoms detailed under the head of acute bursitis are present, but in many cases the constitutional and local symptoms are very slightly marked. Subcutaneous rupture sometimes occurs, either spontaneously or from slight force. This results either in a cure or in

¹ Dupuytren and others have recorded such cases.

² Clinical Lectures and Essays, 1st ed., pp. 58–66.

diffuse inflammation of the cellular tissue. In rare instances, the skin also gives way, when, practically, a wound of the bursa results. Subacute bursitis usually terminates either by resolution or by passing into the chronic form, although, when neglected, more acute symptoms may supervene, when any or all of the accidents attendant upon acute bursitis may be observed. The contained fluid resembles that seen in acute bursitis, but the changes are not so marked.

Treatment.—This should embrace, if possible, quiet for the affected part, repeated light blistering, or painting with tincture of iodine—either alone or conjoined with firm pressure by means of compresses¹—and proper constitutional treatment, should gout, rheumatism, or syphilis be suspected. Compression acts in two ways in producing absorption, viz: (1) Sufficient irritation is set up in the comparatively bloodless cyst-walls, to produce that degree of congestion which is favorable to osmosis, and, the pressure being persisted in after the removal of the fluid, lymph is thrown out which obliterates the cavity; (2) the over-full capillaries of the sac are emptied, so as to admit of absorption by the support afforded on the one side by the compressing body, and on the other by the closely confined elastic fluid. In addition, experiment has proved that pressure upon the fluid which is around the bloodvessels will favor its absorption. I am thus particular in giving these explanations because they render it clear why iodine, blisters, etc.—which simply increase the vascularity of the cyst-walls—fail when used alone, but when supplemented by pressure often succeed. These measures are only likely to prove successful when the bursa is superficial, and manifestly for the reasons just detailed; since in a deep-seated sac no such pressure can be exerted through the superjacent parts as will either increase vascularity or support the bloodvessels, nor can counter-irritants act for similar reasons.

When the amount of fluid is such as to render it probable that only the prolonged use of the above-mentioned remedies will prove effectual, its withdrawal by aspiration, or by a small puncture or valvular incision, with the application of firm compression over the emptied sac, will save much time. When the cyst wall is thickened, such measures will probably prove unsuccessful, and in this event I would recommend the following procedure. After tapping the cyst under the spray, a seton formed of a few strands of prepared catgut should be passed through the bursa, and then a dressing of numerous layers of carbolized gauze should be applied. Unless the patient complains of pain, the dressing should not be removed for a week or ten days, when the ends of the seton will be found lying in it, the wound closed, and the bursa consolidated.² Another mode of treatment is to evacuate the fluid by a valvular incision, made with a tenotome which should then be used to scarify the interior of the sac, followed by the application of firm pressure. The ordinary seton, though usually a safe remedy, occasionally gives rise to serious consequences. When it is used, the patency of the lower opening should be carefully insured, so as to provide for efficient drainage. These methods are not applicable to bursæ communicating with joints; their treatment will be considered when we come to speak of the special bursæ.

CHRONIC BURSITIS.—Usually of a chronic form at the outset, this affection may be a sequence of an acute or subacute bursitis, generally the latter. It

¹ Sponge is an excellent means of applying compression. The limb should be first carefully bandaged, and the dried sponges should be then firmly secured over the part by another roller. When all is in position the dressing should be wetted, when the sponges will swell, and exert firm, uniform, and elastic pressure.

² Roxborough, *Lancet*, vol. xxxviii. p. 193.

is, as might be expected, usually excited by a slight but prolonged or persistently recurring irritation, such as pressure or friction, or both combined. Gout, rheumatism, syphilis, and plumbism play no unimportant role in the causation of chronic bursitis. Without recognizing this fact it will be impossible to cure certain cases. The effused fluid gradually becomes thicker, until it finally resembles synovia. Again, a brownish or greenish sticky fluid is found, containing a variable proportion of cholestearine. Blood is frequently present, either recent and unchanged, or old and altered, rendering the fluid grumous, or full of a substance like coffee grounds.

So-called "melon-seed" bodies are usually found in varying numbers. They probably arise from three sources. (1) The terminal portions of the vascular fringes which are present in certain of the bursæ become hypertrophied. Their pedicles become elongated and thinned, so that the ordinary movements of the parts rupture them, when they become free. This origin is demonstrated by the appearances presented on microscopic examination, when the spot corresponding to the site of the pedicle is seen to be unprovided with the epithelial covering which is elsewhere present. (2) A second source is from masses of lymph, or clots of blood, which, either torn off from the walls or floating free in the fluid, become moulded by mutual pressure and friction. (3) Rokitansky maintains, from the concentric arrangement of the lamellæ which some present, that they are formed by the successive deposition of layers of lymph from the more fluid portions of the effusion. They usually consist either of pure amorphous fibrine, or of a compact connective-tissue substance, occasionally mixed with cholestearine. In rare instances they may be formed of imperfectly developed cartilage, when, of course, their source is the fringes before mentioned, which sometimes contain cartilage cells.¹ The centres of certain of the larger fibroid bodies are soft, or have actually liquefied, thus giving rise to the idea that they are hydatids, as Dupuytren called them.

It is commonly said that the presence of the melon-seed bodies can be detected by the peculiar crackling produced by their mutual friction when the tumor is handled. This is not an infallible sign, since inflamed serous membranes frequently give rise to a similar sensation upon manipulation, when we know that such bodies are not present. Acting much like foreign bodies, they mechanically excite recurring attacks of inflammation. Although not absolutely incapable of removal by absorption, in the majority of cases they are practically so. It is then clear that their recognition is of importance. Their removal is usually imperatively demanded to insure a permanent cure, while in their absence a different and less severe plan of procedure will often suffice.

Both in subacute and chronic bursitis, an injury may give rise to the sudden effusion of blood, converting the tumor into an hæmatocele. If accompanied by marked ecchymosis of the surrounding parts, this condition may be suspected, but I know no means of positively determining its existence. A blow or any injury frequently gives rise to an acute attack, which may result in sloughing of the thickened bursa. The bursal walls are thickened in differing degrees, usually in proportion to the duration of the disease and the amount of irritation to which the tumor has been subjected. In old neglected cases, where continuous irritation of a low grade has long existed, the sac becomes almost obliterated, and upon section looks not unlike a cured aneurism with its concentric layers of fibrine. One or more central cavities remain, traversed by delicate bands or imperfect membranous septa, producing a reticulated appearance, the cells being filled with either a serous or

¹ At least Cornil and Ranvier describe such in the synovial fringes of joints, with which the fimbriæ of bursæ are analogous.

gelatinous fluid. Such cases must not be confounded with the solid syphilitic variety of bursitis which will be treated of under its appropriate caption.

The pathology of the non-syphilitic cases is very simple. The effused lymph after a time becomes organized as in chronic inflammations of other serous membranes, thus becoming an integral part of the sac wall. Recurring irritation now sets up inflammation of a low grade, both in the normal sac wall and in the pseudo-membranous lining. This results in the effusion of inflammatory products, not only upon the free surface of the old false membrane, but into its substance. In both situations the effusion becomes organized, thus increasing the thickness of the primary false membrane, and adding a new layer upon its free surface which, on further irritation, will itself inflame, thicken, and lay the foundation for a fresh pseudo-membrane. Repetitions of these processes will at last result in almost complete obliteration of the bursal cavity.

Thus it will be seen that the thickened laminated sac wall is, of necessity, only sparsely supplied with bloodvessels, which plainly shows that in such a bloodless condition of parts no absorption of fluid can possibly take place, and that to effect a cure no grade of inflammation will avail, however excited, short of that which will induce suppuration, that is, the formation of a vascular granulation tissue, ultimately causing obliteration of the cavity. Much thickened, solidified tumors are apt, if injured, from their feeble blood supply, especially in persons of syphilitic or broken-down constitution, to become gangrenous and slough out *en masse*. Cognizant of this fact, we should be cautious in attempting to excite a curative degree of inflammation, lest it pass sanative bounds and end in a spreading cellulitis.

Microscopically, the thickened walls consist of fibrillated connective tissue, which in parts is hyaline, having imbedded "the characteristic mother and daughter cells of cartilage."¹ Developed as the cyst-wall originally is, from connective tissue, no surprise need be felt that its inflammatory products should go on to the formation of any one of the connective-tissue class of neoplasms, or undergo characteristic degenerations. Thus calcification, ossification, outgrowths of fibro-cartilage, etc., have been observed.

Treatment.—Where the thickening of the bursal walls is not excessive, the use of the seton, after a preliminary tapping of the cyst and evacuation of the melon-seed bodies, is probably the best plan to pursue. Galvano-puncture has been recommended. Barwell advises that a tenotome should be introduced obliquely under the skin, when the bursal walls should be as freely divided as possible, scarified, and the contents evacuated through the incision. This, followed by pressure, is quite as safe as the seton, and in most cases as effectual.²

If the walls are very much thickened, giving the impression of an almost solid growth, they should be carefully dissected out whenever their anatomical relations are not such as to forbid it. The plan pursued by Volkmann offers advantages where, as in certain chronic enlargements of the pre-patellar bursa, the growth encroaches on those aspects of the joint at which the coverings are so thin as seriously to endanger it in the delicate and prolonged dissection requisite. Under the antiseptic spray, he splits the bursa open, excises an elliptical portion of the wall, removes the melon-seed bodies, and with some dull instrument scrapes away the softer portions of the thickened cyst-wall. The cavity is then carefully washed out with a five-per-cent. solution of carbolic acid, and two thick pads of carbolized gauze are firmly

¹ Trans. of the Path. Society of Philadelphia, vol. v. p. 227, 1874-75.

² Such methods are, of course, only applicable when the bursa does not communicate with a joint.

applied on either side of the incision. If the wound should not gape enough to insure proper drainage, two short drainage tubes are to be inserted perpendicularly into the sac. The space between the pads should be filled with a thick compress of gauze, the whole joint then enveloped in a number of layers of the same, and the limb bandaged to a posterior splint. In from three to four days, adhesion of the sac-walls takes place. As a rule, only three or four dressings are necessary, cicatrization being completed in from two to three weeks. There was slight suppuration in one only of Volkmann's seven cases.

Volkmann has tried this mode of treatment even in acute phlegmonous bursitis with extensive suppuration around the joint, and reports that such cases do quite as well as simple ones. He has also by this plan successfully cured acutely suppurating bursæ. I am convinced that such bursæ should never be packed with lint. Any of the plans mentioned are preferable to this rude procedure, even if the bursa be not inflamed.

HYGROMA.

Many surgeons indiscriminately apply this term not only to mere hyper-secretion due to irritation, but also to cases of very mild subacute or chronic bursitis, with but little thickening of the sac. It should, however, be restricted to cases of hyper-secretion into bursæ, where, by pressure and friction, congestion is induced which relieves itself by effusion, and, the irritation recurring, a degree of congestion is maintained which prevents absorption of the fluid. The *treatment* by simple rest and removal of the cause will often suffice, but if it does not, blisters followed by pressure, with a precedent aspiration where the fluid is present in large quantity, should be tried.

CONTUSIONS OF BURSAE.

The subcutaneous bursæ, when contused, frequently become filled with blood, which is usually painlessly effused. Rest, cold evaporating lotions, etc., usually promptly determine the absorption of the blood. It may, however, persist, when the tumor slowly increases, and, if neglected, may in the course of years attain to a huge size. Either with or without effusion of blood, contusions commonly give rise to acute or subacute bursitis. Again, a slight blow may be the origin of a chronic bursitis. Contusions of the deep-seated bursæ are of graver import, owing to the injury of the superjacent tissues, upon which, of necessity, much of the force must be expended, and also to the confinement of the products of inflammation by the overlying tissues, so that, when the injured sac is in relation with a joint, serious sequelæ are not uncommon. The *treatment* must be conducted on general principles, and has been sufficiently indicated when speaking of acute bursitis.

WOUNDS OF BURSAE.

INCISED AND PUNCTURED WOUNDS OF BURSAE.—These usually terminate in suppuration with obliteration of the bursal cavity. Under favorable circumstances, it is possible that they may heal immediately, as similar injuries of joints occasionally do. Wounds of the superficial bursæ usually are of but little consequence. Rest, efficient drainage, an antiseptic dressing when possible, or, indeed, any dressing suitable to a similar wound which opens the

cellular tissue elsewhere, will be all that is usually necessary. Should acute inflammation or phlegmonous erysipelas supervene, cold evaporating lotions, irrigations with weak carbolized water, poultices, or the bran box—which gives equable support and compression, while at the same time it absorbs the discharges—are indicated, with such incisions as will insure free drainage.¹ The remarks just made about contusions followed by suppuration of the deep-seated bursæ, are equally applicable to a similar condition the result of a wound. If, as is not uncommon, the injured bursa communicates with a joint, we practically have to deal with a wounded articulation. In a wound of a deep-seated bursa near a joint, the diagnosis between a simple bursal wound and one of the articulation will require care, since in both there will be an escape of synovia. If the wound cannot be explored by the finger, our only guides are the direction and depth of the wound, and the knowledge that there is a bursa normally present in its track. Deciding that only the bursa is involved, the next important point to determine is whether it communicates or not with the articulation. This can only be determined by an accurate knowledge of the normal anatomy of the part, combined with a recognition of the fact that, the older the patient, the greater is the likelihood of the bursa opening into the joint. I would most earnestly insist that, in any event, it is better to err on the side of prudence and treat the case as if dealing with an injured articulation, since a deep-seated peri-arthritis suppuration often ends in intra-articular trouble.

Treatment.—Perfect rest, restricted diet at first, efficient drainage, antiseptic dressings, cold, irrigation—in fact, anything and everything calculated to favor rapid healing—should be resorted to. Later in the case, if pus forms, free incisions, with sustaining remedies and appropriate diet, must be prescribed.

LACERATED AND CONTUSED WOUNDS OF BURSÆ.—These usually involve the more superficially seated sacs, and often give rise to the most acute and complicated forms of bursitis. Thus, very commonly, a contused wound over the olecranon, opening the bursa, results in a cellulitis which involves, perhaps, the whole upper extremity, including the axilla, and is accompanied with great pain and marked constitutional disturbance, which in old or elderly patients may prove fatal. Of course, there are all grades of the disease, from that just described to a simple local inflammation. One peculiarity of all wounds and injuries of bursæ is, that they are slow at first to take on inflammatory action. All cases do not exhibit this peculiarity, but in most a distinct interval of from twelve to thirty-six hours—perhaps of forty-eight hours—elapses, when a most acute inflammation rapidly arises.

Treatment.—The treatment is the same that has been already laid down for contusions and incised or punctured wounds of bursæ.

TUMORS OF BURSÆ.

Tumors of bursæ are rare. Mr. Erichsen says that he has met with three or four cases where malignant growths have rapidly appeared in the cicatrices left after the removal of bursal tumors, but justly hints that these may only have been due to the localization of cancer, by the irritation of a previous operation in a patient predisposed to this disease.² Simon has also reported³ a case of fibro-cartilaginous tumor, which sprang from the bottom of a pre-patel-

¹ See also page 137 for general treatment of acute bursitis.

² Med. Times and Gazette, vol. xv. 1857, pp. 476 et seq.

³ Transactions of London Path. Society, vol. i. p. 153.

lar bursa, laid open in consequence of a sinus of two years' duration, the result of a puncture tried as a means of cure. It consisted of large cartilage cells imbedded in a dense fibrous matrix. After removal the patient did well, and no recurrence ensued. Chronically inflamed bursæ, with much thickened walls, are of course liable to the degenerative changes to which all lowly-organized connective tissue is obnoxious. I say connective tissue, for, as I have already shown by a reported case, the inflammatory products are developed into this, with a few scattered cartilage cells. Hamilton says that such bursæ may become calcareous, cretaceous, cartilaginous, or bone-like.¹ Indeed, traces of this latter change have been demonstrated by the microscope,² and a mass of supposed bone has been removed from the post-olecranal bursa.³ There is no reason, *a priori*, why any of the connective tissue growths should not occur in bursæ, such as myxomata, enchondromata, osteomata, lipomata, etc. As the "lipoma arborescens" has been found as a tumor arising from the fringes of tendinous sheaths, and as certain bursæ contain analogous adipose folds, it is not unlikely that similar growths of bursæ may yet be reported.⁴

The fibrous tumors which are solid from the outset, as are certain of those in front of the patella, being probably only one of the later manifestations of syphilis, will be considered when describing syphilitic affections of bursæ.

After sloughing of a bursa, fungous outgrowths are not uncommon. Papillomata of an epithelial character have also been reported.⁵

SYPHILITIC AFFECTIONS OF BURSAE.

The syphilitic affections of the bursæ have only of late years received anything more than the most cursory attention. The writings of the first authors who recognized the fact that venereal diseases attacked the various synovial membranes, do not enable us to determine whether the cases recorded were really syphilitic or merely gonorrhœal, owing to their simply using the term venereal, but not distinguishing between the two affections. Fabre, Swediaur, Hunter, and Babington were the earliest writers who referred to the fact that certain diseases of the joints occurred in secondary and tertiary syphilis, and, as I shall show presently, these at times coincide with affections of the neighboring bursa. Dupuytren and Bonnet both recognized syphilis as a cause of joint disease. Crocq⁶ also met with a few cases. Richet, Cullerier, Follin, Verneuil, Lancereaux, and A. Fournier have published observations to a similar effect. Ricord denies that syphilis does more than influence the course of arthropathies. After a study of the phenomena offered by syphilitic disease of the articular synovial membranes, Verneuil⁷ first described the effects of secondary syphilis on the sheaths of the extensors of the fingers. Five years after,⁸ he pointed out that, in tertiary syphilis, various subcutaneous and tendinous bursæ were the site of gummata. A. Fournier⁹ has confirmed in the most satisfactory way these statements of M. Verneuil. R. W. Taylor¹⁰ and E. L. Keyes¹¹ have also published series of illustrative cases. Scattered through

¹ Principles and Practice of Surgery, 1872, p. 469.

² Pritchett, Trans. Lond. Path. Soc., vol. ii. p. 137.

³ J. Heily, Australian Med. Journal, 1868, vol. xiii. pp. 113-115.

⁴ Billroth, Surgical Pathology, pp. 498, 499.

⁵ Dollinger, Archiv f. klin. Chir., Bd. xxii. S. 697, 1878.

⁶ Traité des Tumeurs Blanches, etc., 1853.

⁷ Gaz. Hebd. de Médecine et de Chirurgie, 1868.

⁸ Loc. cit., 1873.

⁹ Note sur les Lésions des Gaines Tendineuses dans la Syphilis Secondaire. (Gaz. Hebd. de Méd. et de Chir., 1868.)

¹⁰ American Journal of Med. Sciences, 1876.

¹¹ American Journal of Syphilography, etc., April, 1871; Archives of Dermatology, Jan. 1877, p. 169.

the various text-books and journals a few cases can be found, which will be spoken of in their appropriate places.¹

SYPHILITIC BURSTITIS.—Syphilitic bursitis attacks the tendinous bursæ more frequently in women, in contradistinction to *gonorrhœal* bursitis, which affects more often the opposite sex. The subcutaneous bursæ, however, seem to be equally affected in both sexes, although as traumatisms sometimes act as exciting causes, this equality may be more apparent than real, since men are more exposed to such accidents than women.² The tendinous bursæ most commonly attacked are those of the sartorius, semi-membranosus, biceps cruralis, and biceps brachialis. Of the subcutaneous bursæ, the pre-patellar, and that over the olecranon, are the most often diseased. Usually there is a pre-existing gouty or rheumatic taint.³

The gravity of the affection is, as in the other phases of syphilis, in direct proportion to its stage of development. Thus, the further advanced syphilis is, the more profound will be the pathological changes detected. During the secondary period these will be superficial, amounting merely to a chronic, or, more rarely, subacute congestion of the serous and subserous tissues, accompanied or not by a serous effusion. The latter occurs habitually in the chronic form, and presents nothing different from that seen in chronic bursitis. When the effusion is slight, crepitation may be elicited by pressure. Tertiary syphilitic bursitis seems to be confined to but a small number of bursæ, viz., the sub-quadricipital, the pre-tibial, pre-patellar, those of the *patte d'oie*, the sub-tricipital, and a few others.

Here the sac walls are thickened and lined with false membrane. In certain cases a fibroid induration occurs, the bursal enlargement starting as a hard, slowly growing, painless nodule. At times there is a genuine gummatous degeneration of the walls, resulting in a complete effacement of the sac-cavity. Both in this condition and in that just described, where inflammation, either spontaneous or traumatic, arises, sloughing *en masse* often occurs. Guminata, if not removed by specific treatment, pass through the ordinary stages of formation, softening, and ulceration.

Reasoning by analogy—since such appearances have been observed in the joints, and since sensations which would indicate similar conditions have been felt in diseased bursæ—the gummatous stage may not be reached, but ovoid, indurated, elastic patches, situated in the serous, or in the subserous and adjacent fibrous tissues, may be developed. M. Verneuil and others have described cases of a fungous hypertrophy, before referred to, affecting such bursæ as those of the inner ham-string tendons, which in these cases are enveloped in a mass of granulations. The walls of the sac may be destroyed, and even neighboring joints may be opened into. This form of bursal enlargement can only be diagnosed by noting that the fluid removed by tapping is bloody, and filled with floating particles.

Subacute Form.—This is an excessively rare affection sometimes met with at the outset of the secondary period. There may or may not be general symptoms. A slight tumefaction exists, with reddening of the skin, if the bursa be superficial. The pain is usually marked, and at times may be violent, and it is provoked by pressure or movement. There is more or less interference with the movement of the part. There is but little effusion, and crepitation can be felt when the tendon plays over the bursa. The dura-

¹ For much of the information contained in this section, see Chouet, *De la Syphilis dans les Bourses Séreuses*, etc. Paris, 1874; and L. Moreau, *Des Affections Syphilitiques Tertiaires des Bourses Séreuses*. Paris, 1873.

² Chouet, *op. cit.*, pp. 7, 8.

³ Mauriac, *Edin. Med. Journal*, vol. xxi. pp. 275, 448.

tion of the disease is usually from seven to eight days, but recurrences are common, and it may eventuate in the chronic form.

Chronic Form.—This is much more common than the former, and is peculiar to the secondary period. Its course is markedly slow, and symmetry of the lesions is common. The local symptoms are the same as in any other chronic bursal enlargement, except that melon-seed bodies have never as yet been observed. The duration of the disease is from seven to ten months. The effusion will decrease to again return without assignable cause. M. Fournier has pointed out that an abortive form is occasionally seen; an attentive examination of such cases shows, he says, (1) That the pain has a definite site, peculiar, and very circumscribed. (2) That this site corresponds to the course of a tendon. (3) That pressure at this point gives rise to a more or less acute pain. (4) That the pain manifests itself during either active or passive movements.

Diagnosis.—Syphilitic bursal diseases occur most frequently during the tertiary period, and although occasionally seen during secondary syphilis, their recognition must depend on a careful consideration of the various diagnostic points—of which I give the following abstract, condensed from Fournier—since often no incontestable sign of syphilis can be detected.

- (1) The history of a primary lesion.
- (2) The comparative frequency with which such diseases occur in syphilitics, especially in women.
- (3) The association of bursal troubles with other secondary manifestations, or with gummata in the tertiary period.
- (4) Symmetry of the lesions, although this is not at all absolute.
- (5) The presence perhaps of undoubted syphilitic lesions elsewhere.
- (6) The development of the disease contemporaneously with other lesions, and subject to the general evolution of the diathesis.
- (7) The absence of any other assignable cause.
- (8) The failure of ordinary measures, and the prompt response to specific treatment.

The onset of these affections is insidious, and they pursue a chronic course. The symptoms often intermit, above all the pain and the effusion, when this exists. There are also distinct nocturnal exacerbations of the pain.

Treatment.—To a general course of antisymphilitic remedies, local treatment, such as compression and the use of blisters, should be added. By such means the disease is readily relieved.

GUMMATA OF BURSÆ.—Chouet reports a case where such a condition existed in the sheaths of the peroneal muscles, and coexisted with a marked serous effusion (*hydropisie*) of the common extensors. Gummata occur much more frequently than the forms of syphilitic bursitis already adverted to. They present no symptoms which are peculiar, pursuing the course of other gummata, with the three stages of formation, softening, and, unless prevented by treatment, ulceration. Their general characteristics are distinct circumscription, slow growth, slight sensibility to pressure; no spontaneous pain, except in rare instances, and then only when irritated; and, late in the disease, close adhesion to the subjacent bone, etc., and to the superimposed skin, which is of a dull red, coppery, or violaceous color; the glands do not become engorged.

Diagnosis.—This, in the clearest cases, is dependent upon the satisfactory recognition of symptoms drawn from three different sources, viz., a syphilitic history; the intrinsic characters of the disease; and the effect of specific treatment.

- (1) Of course the proof of its nature afforded by microscopic examination of the disease is wanting. In all cases thus far reported, there has been either a distinct history of a previous primary sore, or one of various more or less

indubitable secondary and tertiary manifestations. The primary sore has always been acquired some, even many, years before.

(2) The site and form of the tumor usually correspond to those of a normal bursa, or of one normal to the occupation or peculiarity of the individual. The volume of the tumor is never great, not exceeding that of a hen's egg. The swelling most commonly arises spontaneously, or at most has for its exciting cause a slight pressure or injury. It is indolent and almost non-sensitive. In consistence it is firm, elastic, and equally removed from the soft fluctuation of a hygroma and from the hardness of a periostitis, exostosis, or chondroma. The tumor adheres to the skin and subjacent bone. The integument may be unchanged, but is more usually of a red, brown, or violaceous color, and frequently ulcerated. When this latter condition exists, the ulcer has sharp-cut, precipitous sides, the base is grayish, and the discharge sanious; in fact, it resembles in all respects an ulcerated gumma. At times actual fungosities arise, and protrude through the ulcerated opening. The bone is not denuded or thickened, although at first sight it may so appear. The slow growth and chronic duration of the disease are also significant.

(3) Any ordinary method of treatment applied to gummatous cases, however successful it may have proved in simple ones, meets only with failure. In marked contrast to this is the rapid, sure, and easy cure effected by mercurial inunctions or other applications, conjoined with iodide of potassium given internally. These prove efficient even in the absence of rest, so important an element in the successful treatment of simple enlargements of the bursæ.¹

With such an aggregate of symptoms, I hardly think a careful observer could confound a syphilitic with a simple inflammation of a bursa. However, to obviate all chance of mistake, it may be repeated that a non-syphilitically inflamed bursa, although identical as to site, form, and bulk, is but rarely adherent to the surrounding parts, and never to the bone. The onset of the disease is rapid, the skin is bright red, the heat is more marked, the sensibility is often intense, fluctuation is frequently manifest, and specific treatment is of no avail.

A gumma might possibly be mistaken for a *cold abscess*, which it resembles in its slow course, slight local symptoms, discoloration of the skin, and, when ulceration has taken place, occasional protrusion of fungosities. The antecedent history and conditions, in the case of cold abscess, are those of rheumatism or scrofula, and the onset often coincides with convalescence from certain maladies. The borders of the ulcer are more ragged than clean and perpendicularly cut. Besides, cod-liver oil, tonics, etc., serve a good purpose, while anti-syphilitic treatment proves of no avail.

Syphilitic *periostitis* and *osteitis* are amenable to antisyphilitic remedies, but they are accompanied by acute pain, have not the elastic resistance of a gumma, indeed quite the reverse, and correspond neither in seat nor in form to an enlarged bursa. Finally, should ulceration occur, the probe will readily detect denuded bone. *Bloody effusions* into the bursæ might be confounded with gummata, but the former very often exhibit even at the outset a peripheral ecchymosis, and a certain crepitation on palpation due to the mutual friction of the blood-clots. The fungous form of an ulcerating gumma, when affecting a bursa of the foot, probably forms one of the varieties of perforating ulcer.²

Treatment.—This should be of the “mixed” kind internally, with local mercurial inunction. If sloughing occurs, local stimulants, black or yellow wash, calomel ointment, etc., should be used.

¹ For much valuable information, as well as for the arguments which demonstrate such affections to be really gummatous, see L. Moreau, *Des Affections Syphilitiques Tertiaires des Bourses Séreuses*. Paris, 1873.

² L. Moreau, *op. cit.*, p. 24.

SYNOVIAL HERNIÆ.

Owing to the course pursued by the ligamentous fibres forming the capsules of certain articulations, the synovial membrane at various points receives but indifferent support. This condition is most marked in the wrist and knee-joints. In both there are portions of the capsules, where either from the passage of bloodvessels, or from the angles at which the fibrous bands cross one another, small areas are left almost if not entirely void of ligamentous support. In both, moreover, the surrounding tissues do not afford that even, continuous, elastic support which is given by the muscles to such articulations as the shoulder and hip. What may be termed the popliteal segment of the knee-joint capsule, is unsupported by anything but the loose cellulo-adipose tissue there found. Although both the anterior and posterior portions of the radio-carpal joint are most efficiently supported where the tendons pass over it, the spaces between them can readily yield to a force from within the articulation. An anatomical variation, which, if present, would strongly predispose to synovial hernia of the knee-joint, has been recently reported, viz., an entire absence of the posterior segment of the capsule, the so-called ligament of Winslow.¹ Certain portions of other joints present favoring conditions for synovial herniæ, although thus far, those of the knee and wrist-joint have alone been accurately noted. Either a chronic inflammation of the joint with effusion is the sole cause of these pouchings, or, in addition, a wrench or sprain acts as a determining cause. The joint disease usually consists in osteo-arthritis changes, which are undoubtedly the chief factors, but the importance of the anatomical facts just cited as predisposing causes, seems to have been entirely overlooked.

These herniæ interest the surgeon chiefly on account of their liability to be mistaken for aneurism, and the risk of confounding them with bursæ normally present, but which do not communicate with the joint with which they are in relation. Chassaignac first called attention, at least in the case of the wrist-joint, to the liability of such herniæ being mistaken for aneurism, and clearly pointed out how the error could be avoided.²

In his first case, there was over the swelling a scar produced by a fragment of glass, which had been driven in at this point some years previously. There was an ovoid, pulsating swelling situated over the radio-carpal joint. The pulsation, which was remarkable for its energy and the extent of surface involved, seemed expansive, and did not simply elevate the applied fingers. Examined with the member in its habitual position, it was impossible to avoid the error of considering the swelling an aneurism. Forceful flexion of the wrist at once checked the pulsation. This effect was produced, either by relaxing the tension of the artery stretched over the cyst, or, as in another case reported by the same surgeon, by displacing the vessel, which could be felt pulsating to one side of the swelling.

Diagnosis.—The diagnosis of bursal hernia from aneurism is indicated in the preceding sentences, at least as far as the wrist is concerned. In addition, compression of the artery above the tumor would not produce any subsidence of the swelling, nor in most cases would the pulsation be of an expansile character. Although, from pressure, both bruit and thrill might be present, their characters would probably differ from those of a true aneurism in being detected chiefly over a limited, linear portion of the tumor.³ The diagnosis between

¹ F. J. Sheppard, *Annals of Anatomy and Surgery*, Sept. 1881, pp. 110, 111.

² Soc. de Chirurgie, Séance d'Avril, 1845; also *Gazette des Hôpitaux*, 29 Avril, 1845.

³ Since writing the above I see that Barwell, in the second edition of his work on Diseases of the Joints, has reported a case, on p. 507, which confirms the opinion expressed in the text, at least with regard to linear pulsation.

these herniæ and the normal bursæ of the part is often difficult. Usually old joint trouble will be detected, and in certain cases, by appropriate position and manipulation, the contents of the sac can be forced back into the joint, which becomes distended to again relax when the hernia refills. This symptom, when detected with certainty, is invaluable, but the tumor may communicate with the joint, although it cannot be emptied by pressure, since the opening may be valvular.¹ The sudden appearance of one or more circumscribed painful tumors around the circumference of an articulation, after a sprain of a joint which is the subject of chronic inflammatory changes, would clearly indicate what has occurred.

Treatment.—If rest on a splint, with counter-irritation, pressure, and inunction of iodine ointment, do not succeed, the case had best be left to nature. At most, a careful aspiration might be practised; but all more energetic operative treatment should be avoided, owing to the risk, nay certainty, of the joint becoming secondarily more or less involved.²

AFFECTIONS OF SPECIAL BURSÆ.

No special therapeutic directions will be given under this heading, except when the relations of the particular bursa under consideration demand a departure from the plan of treatment recommended for the different varieties of bursitis. Thus, the use of the seton, incision, or excision may be mentioned as indicated in a given case, while the exact method of carrying out the treatment cannot be repeated in each instance; so that the reader is referred to the sections on acute, subacute, and chronic bursitis for the more elaborate consideration of the modes of dealing with these conditions. All bursæ which have been described, whether normal or accidental, will be mentioned; but only those, the enlargements of which are liable to be mistaken for other diseases, or which are affected so commonly as to require special consideration, will be treated of *in extenso*.

BURSÆ OF THE HEAD AND NECK.

A bursa is found in the orbit, lining the pulley of the tendon of the superior oblique muscle of the eye. I have been able to find but one case of its enlargement, reported by Aston Key; but, as he details none of the symptoms, I am unable to give any diagnostic points. It was cured by puncture with a cataract needle. There is a bursa situated over the external occipital protuberance; another over the external face of the temporo-maxillary joint; one behind the angle of the inferior maxillary bone; one at the inferior border of the symphysis menti; and one behind the zygomaticus major and duct of Steno, passing beneath the anterior border of the masseter muscle, where it comes into relation with another bursa placed close to the coronoid process of the lower jaw. These two bursæ often communicate, and under such circumstances extend to the base of the cranium. The internal boundary of these twin bursæ is the buccinator muscle, to which they adhere.³ Certain rare cysts of the cheek, which may extend to the base of the cranium, probably arise from an enlargement of these bursæ.

A bursa surrounds the tendon of the digastric muscle just above the body

¹ Bryant, *Manual of Surgery*, 3d Amer. edit., p. 767.

² W. M. Baker, *St. Bartholomew's Hospital Reports*, 1877.

³ Verneuil, *Bull. de la Soc. Anat.*, 1857, t. xxvi. p. 153

of the hyoid bone; another exists between the middle tendon of the omohyoid and the under surface of the sterno-mastoid muscles; another over the angle of the thyroid cartilage (pre-thyroid); and another between the layers of the middle thyro-hyoid ligament, or between the ligament and the adjacent surface of the hyoid bone (infra-thyroid)—this bursa may be double. Bursal spaces may be found anywhere from above, and even behind, the hyoid bone, to the cricoid cartilage, and are usually strictly median; but they are sometimes double, and, under such circumstances, are placed close on either side of the median line, or even several lines from it. Another bursa exists between the genio-glossi muscles (supra-thyroid), an accidental one¹ between the greater cornu of the thyroid cartilage and the inferior constrictor of the pharynx, and a large one between the trachea and aorta, usually extending from the origin of the innominate artery to that of the left carotid, and reaching from the upper border of the aortic arch to the bifurcation of the trachea. Sometimes a second one is placed posteriorly to this bursa, or a small one is found between the left carotid and the trachea, while the usual large one is located more to the right. Calori² calls these bursæ aortico-tracheal, and says that he found one or all present in thirteen out of forty dissections. When, as is sometimes the case, the pericardium is prolonged upwards and to the left behind the aortic arch, the aortico-tracheal bursa is small. Calori also figures a second bursa, more commonly found than the former, placed beneath the isthmus of the thyroid gland, to the upper margin of which it sometimes extends; this he calls thyro-tracheal. It is usually single, but if the thyroid isthmus be incomplete, there may be two bursæ, placed one on each side of the median line. This bursa is most commonly present when the pyramid of the thyroid is well developed, and especially if it is attached to the hyoid bone. When the musculus thiroideus of Soemmering—the elevator of the thyroid gland of G. F. Meckel—is present, a small bursa may be interposed between it and the thyroid cartilage. Calori figures one such in a case of goitre. This author also describes two small bursæ, placed one on each side between the crico-thyroid muscles and the lateral thyroid lobes, which he calls crico-thyro-thyroidean. They sometimes extend forwards so as to be partially interposed between the trachea and the thyroid gland. They are sometimes multiple, Calori having found in one case three sacs to the right and two to the left of the median line. A bursa is commonly found over the vertebra prominens.

ANTE-THYROID BURSÆ.—According to Hamilton,³ all varieties of bursal tumor which occur in the laryngeal region are more common in females than in males. Elsberg's dissections,⁴ however, have shown that the bursæ themselves are of more frequent occurrence in male subjects. He explains the apparent preponderance of diseases of these bursæ in females by stating that women often consult a surgeon for the removal of such tumors for the cosmetic effect, to which men are generally indifferent. The bulk of these ante-thyroid hygromas varies from that of a hen's egg to that of a small orange. They are subcutaneous, smooth, thin-walled, and elastic, are firmly attached to the larynx, and usually contain a thin yellowish serum. Almost invariably situated exactly in the median line, their site varies from a point just above the thyroid to one over the cricoid cartilage. They may temporarily disappear, to again recur, or, in very rare instances, the tumor may never refill. An occasional termination, as with the other two varieties, is spontaneous rupture into the larynx. These tumors are always of slow growth, and their

¹ W. Gruber, *Archiv f. Anat. Physiol. u. wissenschaft. Med.* Leipzig, 1875, S. 590.

² *Mem. della Accad. di Bologna, seria terza, tom. v.* 1874, p. 335.

³ *Med. Record*, Feb. 1, 1875, p. 545. Hamilton calls them Super-laryngeal tumors.

⁴ *Ibid.*

causation is obscure. I have seen subacute inflammation induced in this bursa by a fall upon the buttocks, through the backward impulse of the trunk producing forcible extension of the head.

INFRA-HYOID BURSA (*Sub-hyoid* or *Thyro-hyoid Hygroma*, *Sub-hyoidean Ranula*).—Except for their higher and somewhat less superficial position, and their occasional interference with respiration and deglutition, the history and symptoms of tumors of this sac closely correspond to those of the ante-thyroid bursa.

Diagnosis of Ante-thyroid and Infra-hyoid Bursal Tumors.—As both these bursæ move in respiration and deglutition, there is some risk of confounding their tumors with cysts of the thyroid gland. Their history, the evidently healthy condition of the gland, and the bloody, grumous character of the fluid evacuated by the exploring needle, render the diagnosis clear. The decision as to which of the two bursæ is involved is of no practical moment.

Treatment.—Injection with tincture of iodine, after tapping, is probably the safest and best mode of treatment. Incision, with subsequent packing with lint, will effect a prompt and safe cure.¹ Excision is in many cases difficult, dangerous, and sometimes impossible to complete. This operation is quite often followed by troublesome fistulæ, which are hard to cure. J. H. Pooley² has suggested that certain congenital median fistulæ may arise from ante-natal disease of these bursæ. These median fistulæ are in marked contradistinction to those defects of development resembling “gills” (*branchial fistulæ*), which are always lateral.³

SUPRA-THYROID BURSA.—The only case of tumor involving this bursa which I have been able to find recorded, is one reported by C. Wagner,⁴ which presented the following symptoms: A chronic, slowly enlarging swelling, of the size of a walnut, was felt over the thyro-hyoid space. The sensations imparted to the finger were those of a fibro-cystic growth. Some hoarseness and slight cough were complained of. By means of the laryngoscope a large tumor, situated to the left side of the base of the tongue, was readily detected; it pushed the left ventricular band beyond the median line. The swelling was twice incised in the throat, giving vent to a quantity of glairy bursal fluid, but rapidly refilled. After three injections of a weak iodine solution, a complete cure was effected. I myself saw a patient, some ten years ago, who presented all the above symptoms, with difficulty of deglutition, respiration, and articulation; but, unfortunately, I have no notes of the case.⁵ Marked enlargements of this sac would interfere with deglutition, respiration, and speech, more than those of any other of the thyroid bursæ.

Treatment.—After preliminary tapping, a solution of iodine should be injected into the sac. With the aid of the laryngoscope this can be readily done by means of a small syringe, provided with a hollow platinum needle, the point of which should be passed through the pharyngeal wall of the tumor. Should this induce suppuration, an incision must be made at the same place. Œdema glottidis must be carefully watched for if the inflammation runs high, and on its appearance should be promptly treated.

¹ See section on General Treatment, for risks, disadvantages, etc.

² Medical Record, loc. cit.

³ Peaslee, Ibid.

⁴ Ohio Med. and Surg. Jour., 1877, ii. p. 328.

⁵ In both these cases I merely infer from the situation of the tumor that this bursa was involved, since if the infra-hyoid sac had been enlarged, it would probably rather have advanced outwardly instead of towards the larynx, while the natural position of the supra-thyroid bursa would almost necessitate the latter course.

BURSA OVER VERTEBRA PROMINENS.—This bursa is quite large. Inflammation, accompanied by a good deal of pain, may be set up by the pressure of a heavy overcoat or other clothing. The diagnosis must depend on the situation of the affection, the tenderness of the part, and the characteristic signs of bursal swelling so often adverted to.

Treatment.—Lead-water and laudanum applications should be made use of at night, while during the day all pressure of the clothing should be removed. To fulfil this indication, Agnew¹ has successfully employed a circular pad stuffed with cotton, and kept in place by being stitched to the clothing. Although I am unaware of any case demanding more radical measures, should such occur, those remedies should be employed which were described in the general remarks upon the treatment of diseased bursæ.²

BURSÆ OF THE TRUNK.

These are infrequent, and are more apt to be adventitious than normal. They are found in the lumbar region, and upon the sides of the vertebral column, in those who carry burdens; over the sternum in cabinet-makers, from the pressure of the brace; over the xiphoid cartilage (*bursa hyper-xiphoides*³) in rachitic children; over the anterior superior spine of the ilium; and over the coccyx. A synovial hernia communicating with one of the sternochondral joints in an infant, has been reported. Bursæ are also found over gibbosities of the spinal column. A bursa has been found over the tuberosity of the first rib, between it and the dorsal muscles. Duval⁴ reports a bursa beneath the pubic attachment of the rectus abdominis. This sac is liable to become inflamed at the close of attacks of croupous pneumonia, when pain, which is exasperated by any movement which calls into play the rectus abdominis, is felt at the pubic origin of the muscle.

BURSÆ OF SHOULDER AND VICINITY.

A bursal sac is commonly found over the acromion process of the scapula, in timber-carriers, and another beneath the acromion, between this process and the coraco-acromial ligament on the one hand, and the capsule on the other—the *sub-acromial*. This is the largest bursa related to the shoulder, and in elderly persons it often communicates with the interior of the joint by a large opening. Another large bursa is placed between the subscapular muscle and the neck of the scapula and contiguous portion of the shoulder-joint capsule, into which it often opens; more commonly a second, smaller one occurs, situated more externally, between the subscapular tendon and the capsule of the joint, with which, when present, it almost invariably communicates. A generally, although not invariably, constant bursa is placed between the tip of the coracoid process and the capsule; one or more bursæ have been reported above this process (*supra-coracoid*); another elongated one is sometimes found between the united tendons of the coraco-brachial and short head of the biceps on the one hand, and the capsule on the other; one over the front of the clavicle (accidental); one over the root of the scapular spine, beneath the trapezius; an occasional one, which opens into the joint, placed between the infra-spinatus muscle and the capsule; one between the insertion of the tendon

¹ Principles and Practice of Surgery, vol. ii. p. 840.

² Vide supra.

³ Jacobi, Am. Jour. Obst., 1875, vol. viii. p. 165.

⁴ Gaz. des Hôpitaux, Mai, 1854, p. 250.

of the *teres major* and the humerus, extending also between this tendon and that of the *latissimus dorsi*; another between the *latissimus dorsi* tendon and the humerus; one between the biceps tendon and the humerus; one between the *latissimus dorsi* and the inferior angle of the scapula; and finally, one beneath the same angle of the scapula and the chest-wall (*infra-serratus*).

SUB-ACROMIAL OR SUB-DELTOID BURSA.—This sac is quite often affected, and, owing to the somewhat peculiar symptoms to which its inflammation gives rise, I deem it worthy of an extended notice. It is probable that the so-called luxation of the long head of the biceps is really due to chronic bursitis of this sac, for all the symptoms attributed to that lesion are present in such an inflammation, with others which are irreconcilable with the existence of any displacement of the tendon.

Symptoms.—There is some wasting of the shoulder muscles in chronic cases. A fluctuating swelling, easily felt when the deltoid is relaxed, and bulging on either, but preferably on the anterior, side of the tendon, will often be found in chronic cases characterized by marked effusion. Pressure will perhaps drive the fluid from one side to the other, and under such circumstances melon-seed bodies can be detected slipping from beneath the fingers. If the arm is supported, its movements are not painful when it is applied to the side, but when unsupported, or when traction is made upon it, pain will follow movement. Pressing the joint surfaces together produces no discomfort. If the arm be abducted beyond a right angle, there will be pain, while at the same time a peculiar crackling sensation, sometimes accompanied by a feeling as of a foreign body slipping away under the acromion, will be felt. If the arm is brought to the side these symptoms will cease, and as the arm is depressed a slipping sensation, as if due to the reduction of a displaced tendon, will often be perceived. There will be more or less flexion of the forearm, due to rigidity of the biceps, and a feeling of fatigue at the bend of the elbow will be complained of.

It will be seen that these symptoms closely correspond to those which are said to be produced by luxation of the tendon of the biceps. Jarjavay,¹ disbelieving in luxation of the tendon, on the anatomical grounds that the exceptionally strong fibrous sheath by which it is bound down could not be ruptured without simultaneously tearing off the *supra-spinatus* tendon, and that such a degree of force would almost necessarily luxate the humerus, examined a number of patients with the following results. The seat of the most marked acuity of pain was on a line with the apex of the acromion, two and a half centimetres outside of the position of the tendon. Every movement except that of abduction merely produced slight discomfort, but during this movement the pain and crackling were marked. In extreme abduction, rotation either outwards or inwards produced similar pain and crackling, except when an assistant depressed the proximal extremity of the humerus by pressure over the upper part of the arm, whereby the two bursal surfaces were no longer nipped between the tuberosity of the humerus and the under surface of the acromion. By dividing the origin of the deltoid and laying the muscle up over the clavicle, the bursa will be exposed, when it will be easily seen that a twist of the arm, especially when either flexed or extended, may stretch or actually tear its walls. This is just the injury supposed to produce luxation of the biceps tendon. If now the arm be abducted, the bursal walls will be folded up so as to form a sort of collar in advance of the greater tuberosity of the humerus, so that it will be readily seen how, when thickened by inflammation, these now rigid plications will be compressed under the

¹ Gazette des Hôp., Fév. 1868, p. 97.

acromion, and, when forced beneath it by the pressure of the humeral tuberosity, will by rolling upon one another produce the crackling and slipping sensations. These are synchronous, and both correspond to a point two and a half centimetres *outside* of the line of the tendon. Persons following laborious occupations often present marked thickening of the bursal walls, with fibroid bands traversing the cavities. If an injury be now received, the surgeon on examination will detect the symptoms already given, and may diagnose luxation of the biceps tendon. Jarjavay, in a case of undoubted acute bursitis of this sac, detected every one of the typical symptoms of such an injury.

Diagnosis.—Although many bursæ, when enlarged, may receive a transmitted pulsation from the artery, and so simulate aneurism, their mobility, the nature of the pulsation, etc., will readily eliminate any source of error. Strumous arthritis is the only affection likely to be confounded with a chronic bursitis of this sac. A review of the symptoms of bursitis, with a remembrance of the fact that, except in abduction, motion produces only uneasiness, when the arm is supported, while the joint-surfaces can be pressed together without pain being developed, will insure a correct diagnosis. When the bursa communicates, as it often does, with the shoulder-joint, the disease may extend from the former to the latter, or *vice versa*.

Treatment.—The application of electricity to the weakened muscles, counter-irritation, and passive motion, are what Jarjavay has found efficient in the chronic cases; while in the acute, treatment must be conducted on general principles. No operation beyond antiseptic puncture or aspiration should be attempted for the cure of any enlarged bursa in this region. More severe measures so often result in serious consequences, that it would be bad surgery to run unnecessary risk when safer measures will suffice. The aspirator or exploring needle should be used to detect pus, which, if found, should be drawn off by the former instrument. If this fail to effect a cure, the suppurating sac should, of course, be laid open, but only antiseptically, as the bursa might communicate with the shoulder-joint.¹

SUB-SCAPULARIS AND INFRA-SPINATUS BURSÆ.—These are mentioned merely because, from their usually communicating with the joint, they are apt, when the latter is diseased, to become secondarily involved. When primarily affected, pain will be developed by drawing the arm away from the side, and at the same time rotating it either inwards or outwards; pressing the joint-surfaces together produces no discomfort.

INFRA-SERRATUS BURSA.—By this I mean the bursa situated between the inferior angle of the scapula and the chest-wall. It is not constant, but frequently present in those performing manual labor. I give prominence to the enlargement of this bursa, because of the peculiar friction-like crepitation or creaking which is not an infrequent precursor and concomitant of its formation. This—most distinctly felt and heard over the inferior scapular angle—is propagated to the point of the shoulder, and even along the arm. This pseudo-crepitus has been mistaken, by careless or inexperienced observers, for either a fracture of the ribs or scapula, or for a dry arthritis of the shoulder-joint. Boinet was the first to point out this symptom, and Terrillon has written two able papers on it. To a very minor degree, this symptom can be developed in apparently healthy individuals, by strongly pressing the scapula against the thorax while the bone is forced to execute various movements.

¹ "Hyper-distension" may be substituted for an antiseptic dressing, when the essentials for the latter are wanting.

For the production of this symptom, the scapula must be in such a position that its inferior angle is closely applied to the thorax. It is due to one of three conditions, viz., (1) an exostosis on the ribs or scapula, which has caused an absorption of the subscapular and serratus magnus muscles, thus allowing the two bony surfaces to come into contact; (2) a localized projection of the ribs due to a contraction of the chest, following pleurisy, for instance, with the same atrophy of the muscles; or, finally, (3) a primary atrophy of the muscles, such as is common in ankylosis of the scapulo-humeral joint, which will admit of the normal scapula and ribs coming in contact. This latter condition preëminently gives rise to exaggerated movement of the scapula, which is an important factor in the production of this bursa. All these conditions have been verified by actual post-mortem examination.

Symptoms.—The inferior angle of the scapula is raised by a fluctuating swelling, which bulges from beneath both the axillary and vertebral borders of the bone. The same portions of the bone are slightly raised in cases where the effusion is too slight for detection, as if from paresis of the muscles. There is marked feebleness of the shoulder, especially in elevating the arm. There is no tenderness, nor any symptom of disease of the subjacent ribs or neighboring vertebræ. The ordinary crackling from melon-seed bodies can be readily detected, but where there is much effusion, the peculiar “cracking” cannot be developed, owing to the separation of the two bony surfaces.

Diagnosis.—This can be readily made by remembering that any position of the upper extremity which prevents accurate contact of the inferior angle of the scapula with the thorax, will prevent either the hearing—for it is sometimes very loud—or the feeling of the crepitus. By bringing the arm, much elevated, firmly across the chest, the cracking cannot be elicited, so that the idea of fracture can be no longer entertained. By fixing the scapula in this position by means of an assistant, manipulation of the shoulder-joint—when the case is not due to ankylosis, true or false—will soon prove that the articulation is healthy.

Treatment.—The trapezius, rhomboids, elevator of the scapular angle, and serratus magnus, seem to be the weakened muscles. Electricity appears to be useless, so that Terrillon has been compelled to resort to a mechanical apparatus which firmly fixes the scapula against the chest-wall. This is the only remedy which has proved successful.

BURSÆ OF ELBOW AND VICINITY.

A bursa is situated beneath the brachialis anticus; another over each condyle of the humerus; one between the common origin of the extensor carpi radialis brevis and the extensor communis digitorum on one side, and the head of the radius on the other;¹ a subcutaneous one over the olecranon; another beneath the triceps tendon over the upper surface of the olecranon;² and one between the tubercle of the radius and the tendon of the biceps.³ It is said that a bursa is sometimes found over the superior part of the left forearm in wall-paper manufacturers.

¹ I have seen, in one case, considerable inability to use the forearm in enlargement of this bursa, due probably to pressure upon the radial or posterior interosseous nerve.

² This is often a mere prolongation of the synovial capsule of the joint. (Barwell, *Diseases of Joints*, 1881, p. 488.)

³ Dr. D. H. Agnew reports a case of chronic enlargement of this bursa, which, by pressure upon the median and posterior interosseous nerves, produced loss of power in the forearm muscles. (Transactions of the Pathological Society of Philadelphia, vol. ii. p. 139.)

SUBCUTANEOUS OLECRANAL BURSA.—Owing to its position, this sac is exceedingly apt to be contused or wounded. Such injuries, especially contused wounds, are apt to be followed by phlegmonous erysipelas of the whole upper extremity, involving even the axilla. In the old this may prove fatal.

DEEP OLECRANAL BURSA.—This is not always an independent sac, but a mere process of the synovial capsule of the joint. If it does not open into the joint, the diagnosis of enlargement of this bursa from joint-disease can be readily made by noting the absence in the former of "puffiness between the inner condyle and the olecranon process, when the arm is bent at right angles," . . . and by "the infallible test . . . that the line of junction between the head of the radius and the humerus is as clear and well defined as ever."¹

Treatment of Bursal Enlargements about the Elbow.—Strict rest on a splint, with local and general antiphlogistics, should be tried. If phlegmonous erysipelas supervenes, early and free incisions, with supporting treatment, are indicated. Simple enlargements of the various elbow bursæ should be cautiously dealt with, owing to their relations to the joint. I once laid open the bursa over the head of the radius and packed it with lint; spreading cellulitis resulted, the joint became involved and was destroyed, and death resulted from septicæmia.

BURSAE OF WRIST AND HAND.

Like those of the ankle, the bursæ of this region usually occur as bursæ synoviales (synovial sheaths for the tendons), and the consideration of their diseases belongs to another article. Those which may be fairly described as bursæ rather than synovial sheaths, are only two, viz: one over the styloid process of the radius, and another over that of the ulna. In the hand, bursæ are constant upon both the dorsal and palmar surfaces of the metacarpophalangeal articulations; over the dorsal surface of the inter-phalangeal joints; occasionally over the radial border of the first phalanx of the forefinger of the right hand, in joiners; over the posterior faces of the second and fifth metacarpals of the right hand, in workmen manufacturing wall-papers;² and over the first inter-phalangeal joint of the right index finger in writers.

Nothing special need be said of the bursæ of the wrist, which have been sufficiently considered in speaking of synovial herniæ. Those of the hand cannot be so cursorily dealt with, since the bursæ over the dorsal aspect of the inter-phalangeal joints, especially that of the forefinger, and also those of both the dorsal and palmar aspects of the metacarpophalangeal joints, are subject to a painful form of enlargement. Rheumatic and gouty individuals are the chief if not only sufferers, unless traumatism be the exciting cause. Usually these enlargements appear to be caused merely by the natural use of the parts. Perhaps prolonged writing or other light manual labor may be the starting point. The same amount and severity of work in any other than a rheumatic or gouty individual would produce nothing beyond temporary fatigue. The affected parts swell, become painful, stiff, and tender. All the symptoms are worse on rising in the morning, and are ameliorated during the day. Rest at first entirely relieves the trouble, but the least exercise renews it; the periartritic tissues crepitate when pressed upon, thickening results, and the member becomes almost useless. The weather evidently affects the parts, and intercurrent attacks, affecting other bursæ, or perhaps joints, are not uncommon.

¹ Barwell, op. cit.

² My authority refers to French workmen.

Teno-synovitis usually coexists, or at least appears to do so. The diagnosis is too manifest to need further words.

Treatment.—The success of this depends upon the recognition of the constitutional vice. The part should be put at perfect rest until most of the local heat and tenderness have disappeared. A light vulcanite splint, moulded to the finger, so as to keep it semi-flexed, or some similar arrangement, should be employed. Absorbent cotton, wet with a five-per-cent. solution of lactic acid, should be kept applied, unless the skin becomes sore, when some sedative astringent, such as hamamelis, can be used. Or, again, spirit lotions, containing various proportions of iodide of potassium, applied in the same manner, will prove efficacious. After the disease becomes more chronic, the surgeon must remember not to keep the joint quiet too long for fear of ankylosis. Passive and active movement, cautiously made, rubbing, and hot alkaline bathing or douching, should be used. At times the judicious application of the thermo-cautery, heated in boiling water, may prove useful. Usually mere reddening of the skin is all-sufficient, but occasionally blistering by this means will be necessary, before any useful result can be obtained. An elastic rubber bandage often serves an admirable purpose in removing the remaining stiffness and thickening of the inter-phalangeal joints. This bandage should be cut from a strong rubber capote, since no other rubber tissue is thin enough, and may be secured by a piece of bobbin attached to one end.

Constitutional and strict dietetic treatment are of paramount importance. Iodide of potassium, in small doses, guarded by muriate of ammonium, either with or without colchicum; the natural alkaline waters; and, above all, a residence at some appropriate spa, will act better than any mere local measures. The Hot Sulphur Springs of Virginia or Florida, the Richfield Springs, or the Buffalo or Wolf Trap Lithia Springs, are the best in this country. The only natural water used at the patient's house, of which I have any experience, is the Buffalo Lithia water, which I have used with undoubted advantage in my own person. It should be taken in large quantities and for a long time. Having had no personal acquaintance with the effects of the English and Continental natural waters, I prefer to refer my readers to such writers as Barwell and others who have had ample experience in the treatment of rheumatic and gouty affections by such means.¹ If any surgeon who reads this has had the care of one of these annoying cases, no apology will be needed for this extended notice. The disease is so incapacitating, and so difficult of cure, that having had successful personal experience in its treatment, I am glad to be able to add my mite to the knowledge of its therapeutics. It is essentially a chronic affection, and, in consequence, treatment must be persisted in for months and even years; but I believe that in the end most cases can be cured, or that at least the disease can be so kept in abeyance that the patients practically recover.²

BURSÆ OF THE ISCHIO-FEMORAL REGION.

A large bursa exists between the ilio-psoas muscle and the capsule of the hip-joint, with which in adults it communicates; another, subtegumentary, is often found over the trochanter major; one is present between the trochanter major and the gluteus medius, and often extends betwixt the tendon of this muscle and that of the pyriformis although at times there is a separate

¹ Barwell, *op. cit.*, p. 398.

² Of course the distinction between "tonic" and "atonic" gout must be made with reference to treatment. The reader is referred to Barwell (*Diseases of the Joints*, London, 1881, pp. 220-245), for much valuable advice as to the treatment of rheumatic and gouty arthritis, much of which is applicable to the therapeutics of the variety of disease which I am here describing.

bursa for the latter. A bursa is interposed between the tendon of the gluteus minimus muscle and the great trochanter; another between the lower part of the trochanter and the contiguous portion of the shaft of the femur, and the tendon of the gluteus maximus; below this, a second between the tendons of the gluteus maximus and the vastus externus muscles; one beneath the pectineus, near its insertion into the femur; and one between the external obturator muscle and the back of the neck of the femur. A large bursa is found between the quadratus femoris and the lesser trochanter; one between the trochlear groove of the ischium and the tendon of the obturator internus, often communicating with another, quite commonly present, which is situated between the back of the capsule and the gemelli, and the obturator internus; bursal interspaces exist between the obturator internus, the quadratus femoris, and the back of the capsule; a bursa is found beneath the conjoined tendon of the semitendinosus and biceps; another beneath the origin of the semimembranosus; and an accidental one over the upper and outer part of the thigh.

ILIO-PSOAS BURSA.—When enlarged, this presents a fluctuating tumor over the front and inner part of the thigh. It may reach a large size, even that of a child's head, and may have portions which feel hard to the touch. When suppuration occurs, the pus points below the edge of the great gluteal muscle to the outer side of the femoral vessels, or in both situations. The subjacent pelvic bones were necrotic in one reported case. The limb is flexed from irritation of the ilio-psyas muscle, and to remove pressure from the inflamed sac, and in consequence a varying degree of lameness results.

Diagnosis.—This affection can hardly be confounded with any other except hip-disease, the differential diagnosis from which will be presently referred to. From *femoral hernia* it can be distinguished by the absence of impulse on coughing, of resonance on percussion, and of the characteristic sensation when reduced—supposing it to be possible in a given case, when very small, to force the contents into the hip-joint—and by the internal position of the femoral vessels. From *psyas abscess* it may be distinguished by the absence of signs of caries of the vertebræ, and by the history. From *coxalgia* it can be distinguished by the absence of pain on pressure over or behind the trochanter major, and by the fact that, by cautious manipulation, flexion can be freely made without elevation of the pelvis. This cannot be done in hip-disease, since, after a limited degree of flexion has been attained, the pelvis, in that affection, moves with the femur. If the ilio-psyas muscle be relaxed, no pain should be experienced in bursal inflammation when the head of the femur is forced into the acetabulum, either directly by pressure or blows on the trochanter, or indirectly by force applied to the knee. Of course no grating can be detected in moving the joint even under anæsthesia. The pain is never referred to the knee.

Barwell¹ calls attention to the pain over the origin of the gracilis and adductor muscles, which is common to bursitis of this sac and impacted fracture of the femoral neck. I can hardly think that there is any likelihood of the two affections being confounded, and refer to the subject merely because so distinguished an authority as Mr. Barwell has considered the mistake possible.

Treatment.—As this sac usually communicates with the hip-joint, aspiration alone should be resorted to, followed by the use of blisters and pressure. If pus forms, and is evidently making its way to the surface, should aspiration fail, a free opening must be made with the strictest antiseptic precautions.² Any

¹ Diseases of Joints, 1881, p. 489.

² Shæffer reports (Centralblatt f. Chir., 1880, Bd. xvi. S. 433) a case of suppuration of the ilio-psyas bursa where the sac opened into the articulation, in which treatment by incision and drainage was followed by recovery with a movable joint. I have not seen the original paper, but only an abstract which gives the above facts.

resulting sinuses, necrosis, etc., must be treated on general principles, always bearing in mind the proximity of the hip-capsule, and the liability of the joint to become involved.

BURSA OF THE GLUTEUS MAXIMUS.—The importance of recognizing disease located in this bursa will become clear when its affections are described. It is probable that caries of the trochanter sometimes arises from suppuration of this bursa.¹ The patient will probably refer the disease to a severe blow received some time previously over the trochanter major, which produced temporary pain and lameness, and was followed by low inflammation, wasting of the thigh, and flattening of the buttock. When seen by the surgeon, the thigh is usually adducted² and flexed upon the pelvis, which follows the motions impressed on the femur. In certain cases there is a decided simulation of lengthening of the limb, and the trochanter is prominent, and seemingly lower than on the healthy side. Extension or rotation inwards, which puts the gluteal muscles on the stretch, immediately causes pain, not in the joint, but over the trochanter and upper part of the thigh. Pain in the joint can neither be elicited by forcing its surfaces together by pressure on the trochanter, nor by the upward force imparted to the femoral head by blows, etc., upon the knee, although local pain of varying violence may be complained of over the trochanter when this is pressed upon. Suppuration occurs slowly, often forming large accumulations, which finally burst, usually with marked amelioration of all the symptoms. In some cases all the movements of the joint now become free and painless, and the patient rapidly and permanently recovers. In others, either a slow and tedious recovery takes place, or, a sinus resulting, the case closely simulates one of hip-disease.

Diagnosis.—Although a careful consideration of the above-named characteristics of the disease should always lead to a correct opinion, yet, as such cases have been mistaken by experienced surgeons for morbus coxarius, the symptoms already given may be recapitulated, with some additional points. There is always a history of a violent blow upon the trochanter, which is usually rapidly followed by swelling over the injured region. There is no pain in the hip itself, nor any referred pain in the knee. Although of necessity pressure behind the trochanter gives pain, pressure applied in the groin reveals no tenderness, and under an anæsthetic the joint movements are found to be perfectly free and natural. Exploration of the sinuses, when such exist, will detect no bare bone, and will show that the disease is confined to the bursa. The rapid recovery after the pus is evacuated, with the restoration of the joint movements, is in marked contradistinction to what is seen where suppuration occurs in the hip-joint itself. Mr. Teale³ hints that certain of the reported cases of rapid recovery, after opening of supposed psoas abscesses, may have been unrecognized cases of disease of the trochanteric bursa.

Treatment.—If the collection is large, aspiration or antiseptic incision should be practised. Should sinuses result, they must be dilated, when the introduction of the finger will readily detect the cause of the slow healing, viz., the constriction and pressure upon the diseased parts by the flat tendon of the gluteus maximus, which must be freely divided transversely. The lining false membrane, etc., should then be broken up by the finger, and the case treated on general principles.⁴

ISCHIAL BURSÆ.—Any of those mentioned may become involved. The disease occurs most frequently in persons whose occupations demand a sitting

¹ T. P. Teale, *Lancet*, 1870.

³ *Loc. cit.*

² Macnab, *Lancet*, Nov. 12, 1870.

⁴ T. P. Teale, *loc. cit.*

posture with an occasional gliding movement, such as weavers and boatmen, whence the names of "Spittalsfields weavers" and "lighterman's bottom." If suppuration occur, troublesome sinuses are apt to result, which must be treated on general principles, by setons or stimulating injections, followed by pressure or appropriate incisions, when such can be safely and advantageously practised. More commonly, however, the bursal walls become much thickened, when either excision by careful dissection, or Volkmann's "antiseptic incision," should be resorted to.¹

OBTURATOR INTERNUS BURSA.—I merely mention the following case incidentally, since its result apparently indicates what is the proper operative treatment for any of the other numerous hip bursæ, if they become enlarged, but do not suppurate. The tumor occurred in the person of a medical man of markedly rheumatic diathesis, and was diagnosed by being rendered tense and prominent only when the obturator internus muscle contracted. Puncture resulted in a rapid and permanent cure. In similar cases appropriate constitutional remedies should be tried, and if these, conjoined with rest, fail, puncture by the aspirator should then be resorted to. Blisters and pressure, for the reasons pointed out when speaking of such remedies, cannot prove useful in any marked degree, owing to the deep situation of this as of most of the other hip bursæ.

ANTERIOR BURSA OF KNEE AND VICINITY.

A bursa quite commonly develops over the external and anterior face of the thigh in street organ-grinders, while in shoemakers one situated more anteriorly and internally sometimes occurs. About the knee, a number are found. One of large size is usually developed beneath the quadriceps tendon (the *sub-quadricepsital*), which often opens into the joint. This may become enlarged in sewing-machine girls who start their machines with the knee. Bursæ are usually found over both the internal and external femoral condyles. One, which is sometimes multiple, is situated over the patella (the *pre-patellar*); one over the tubercle of the tibia (the *subcutaneous pre-tibial*); another between the tibial tubercle and the ligamentum patellæ (the *deep pre-tibial*); and one or more beneath the gracilis, semi-tendinosus, and sartorius tendons, the so-called *patte d'oie* tendons of the French.

BURSA BENEATH VASTUS INTERNUS.—This is occasionally diseased. It sometimes gives rise to obscure symptoms, apparently due to disease of the knee-joint. It is commonly the result of a blow in this region, resulting in an inflammation of this sac, which is accompanied by acute pain, easily relieved by rest and treatment. Recurrent attacks on over-exertion are common, and the limb is weakened.

Diagnosis.—This depends on a history of direct injury, and the tardy progress of the disease, with occasional attacks of inflammation which produce lameness and interfere with flexion—all being due to the development of an oval, hard, tender tumor, under the insertion of the vastus internus, which can be grasped between the fingers and moved, when the muscle is relaxed, but which cannot be detected when it is tense.

Treatment.—This consists of the enforcement of rest and the local use of antiphlogistics.

¹ See Treatment of Acute and Chronic Bursitis.

SUB-QUADRICIPITAL BURSA.—Effusion into this sac gives rise to a swelling of variable size, which bulges out on either side of the rectus tendon. At first sight it closely resembles acute synovitis of the knee. The swelling is painful and fluctuating, and may give rise to marked constitutional reaction; but it is situated above the patella, the upper border of which is its lowest limit, while the two distended fluctuating pouches which in synovitis of the knee-joint are found on either side of the ligamentum patellæ, are absent. The difference is most evident in the erect posture. The patella is not elevated and floated off from the patellar surface of the femur, and in consequence the characteristic tap against the latter bone, observed in synovitis, with the subsequent recoil after the removal of pressure, cannot be elicited. The diagnosis must depend upon the recognition of these symptoms.

Treatment.—When simply inflamed, the treatment recommended for bursitis in general is all that is necessary. Should suppuration occur, aspiration should always be preferred to incision, since this bursa very commonly communicates with the joint in those of advanced years, while such a condition has been observed even in the young. It may not be possible to empty the bursal contents into the joint, owing to the valvular nature of the opening, so that the most prudent plan is in all cases to aspirate, except when the condition of the skin renders it probable that the opening made by the trocar will ulcerate, when the knife under antiseptic precautions may be resorted to. Some one of the bursæ in the region of the knee—and these remarks are equally applicable to other joints—is usually the starting-point of the periarthritic suppuration which so often results in serious injury of the articulation, and occasionally in its destruction. Proper treatment and free opening, thus insuring drainage, will usually prevent damage. The differential diagnosis between intra-articular and peri-articular suppuration mainly depends upon the form assumed by the swelling, and upon whether the patella is floated off from the femur or not.

PRE-PATELLAR BURSA.—This may or may not be of ante-natal formation.¹ This bursa is often traversed by imperfect partitions, and there may be two or more separate sacs. The septa becoming thickened and more vascular, when the bursa is inflamed or irritated, may be ruptured, accounting for some of the blood found in the effusion, and for the rolled-up masses of threads, either attached or free, which are so commonly noticed. Owing to its position, which exposes it to falls, pressure, and friction—in house-maids, stone-masons, *religieuses*, etc.—this sac is more commonly enlarged than any other. Both the acute and chronic forms are often due to the effusion of blood, which undergoes manifold changes and gives rise to various grades of inflammation. The term “house-maid’s knee” is applied to chronic enlargement of this bursa, from its frequent occurrence among domestic servants abroad, although not in this country. Traumatism usually sets up an acute bursitis.²

Acute Bursitis of the Pre-patellar Bursa.—This subject will be treated of somewhat in detail, as suppuration, both in the case of this bursa as well as in that of the others surrounding the knee, is thought by most authors to be the starting-point of peri-arthritis suppuration. When the pre-patellar bursa is acutely inflamed, the anterior aspect of the patella presents a more or less tense, tender, fluctuating swelling, the skin over which is much reddened. The pain is often of a violent, lancinating character. After a few days the

¹ Hamilton’s *Surgery*, p. 469; also A. Pineau, *Étude sur les Épanchements des Bourses Séreuses Sous-cutanées*. Paris, 1866.

² Angioleucitis has been known to give rise to suppurative bursitis. Pineau, *op. cit.*

redness, which was at first circumscribed, becomes diffused, and some œdema is observed. Occasionally, when no history of a blow can be elicited, marked ecchymosis may appear, extending down even to the ankle. Although there is no absolute rule on the subject, inflammation arising from traumatism does not usually show itself for from twelve to forty-eight hours after the injury. The knee is usually somewhat flexed, movements of either flexion or extension being painful, or at least difficult. Fever, headache, furred tongue, and confined bowels, are quite common. Acute bursitis may terminate by resolution or suppuration, or may pass into the chronic form. Acute suppuration has even terminated fatally from septicæmia. Caries of the patella from suppurating bursitis, which resulted, after operative interference, in suppuration in the joint, has been once observed by Erichsen.¹ When acute bursitis of this sac arises from gout or rheumatism, resolution is the rule. Under such circumstances the onset of the disease is violent, but it subsides quickly, perhaps to again recur.

Diagnosis.—In a case of moderate severity this is easy, but when dealing with a very marked bursitis, the question of diffuse cellulitis arises. The correspondence of the tumor with the site of the bursa, its manifest fluctuation from the outset, and the distinct interval between the injury and the appearance of the swelling, are the most reliable points.² The rapid appearance, disappearance, and perhaps reappearance of the disease, coinciding with manifestations of gout or rheumatism elsewhere, indicate its dependence on systemic causes.

Treatment.—Local antiphlogistic measures, aided by constitutional remedies (for rheumatism, etc.), if so indicated, should be prescribed.³ I would caution against the use of the knife, unless pus is certainly present, as death has thus more than once resulted. The presence of pus, unless by the use of the exploring needle, can only be positively determined by the skin becoming purplish and red, and thinning more and more. When pus is present, free incisions must be made, as they must also when phlegmonous erysipelas supervenes, in which case a supporting treatment must be instituted, with iron, quinine, etc. When the bursitis is due to gout or rheumatism, alkalies, salicylic acid or the salicylates, colchicum, etc., must be exhibited.

*Chronic Bursitis.*⁴—True hygroma of this bursa, as before defined, does sometimes occur, but the more common form of “house-maid’s knee” is really either an acute or a chronic bursitis. In the latter case we find a⁵ firm, tense, hemispherical tumor, which projects from the anterior surface of the patella. It may reach the size of a foetal head, but more commonly is not larger than a small orange. Usually confined to the anterior surface of the patella, it may project beyond, overlapping this bone, and coming into close relation with the anterior surface of the joint-capsule. If the walls are only moderately thickened, and if the sac is not too tensely filled, fluctuation is readily detected. Not uncommonly the walls are so thickened that the growth simulates a solid tumor, which is only proved to be cystic when, after removal, a section is made, revealing a larger or smaller central cavity or cavities filled with some kind of fluid. Slight stiffness and interference with extreme flexion are commonly complained of, or a sense of soreness after prolonged exercise. Tumors, solid from the outset, are met with here, but

¹ Science and Art of Surgery, vol. ii. p. 335.

² Nélaton, quoted by Pineau, op. cit.

³ See page 137, for details.

⁴ For a detailed description of the pathological anatomy, appearances, degenerations, etc., see opening portion of this article.

⁵ A. Pineau mentions a case of M. Leroy’s, where three closely related tumors existed. (Op. cit.)

are due to syphilis, being of a gummatous nature. The much thickened, chronically inflamed burse are liable to attacks of acute inflammation, effusions of blood, etc., from any traumatic causes, such as blows or falls. They are apt under such circumstances, chiefly in syphilitic subjects, to become gangrenous and slough out *en masse*, when fungous granulations or troublesome sinuses may result. Melon-seed bodies are often met with. Chalk-stones have been observed in a case of chronic gouty bursitis of this sac.¹ Subcutaneous rupture sometimes occurs, and even the skin may give way. A cure rarely results from the former accident, and the latter is too seldom met with to justify generalization as to its effect.

Diagnosis.—The only point requiring care is to determine as to the existence or not of marked thickening of the sac-walls, the treatment varying according to whether such a condition is or is not present.

Treatment.—In true hygroma,² rest on a splint, the use of blisters, the pressure exerted by an elastic bandage or any other convenient means, with, in very voluminous tumors, a preliminary aspiration, will effect a rapid cure. The same plan will often succeed where the walls are not much thickened by inflammatory deposits. If the walls are markedly thickened, tapping, the employment of blisters, and pressure, with or without a preliminary subcutaneous scarification of the interior of the sac with a tenotome, may be tried. If these expedients fail, the antiseptic or ordinary seton may be resorted to, taking care that the lower opening is kept patent. In the apparently solid forms of bursitis, nothing short of excision, or Volkmann's antiseptic incision, will avail. I totally disapprove of incision followed by packing with lint, for reasons already given. On excising these growths, great care must be taken not to cut the fibrous hood formed by the lateral expansions of the quadriceps tendon, as unpleasant burrowing of pus might ensue. This accident could only happen in the case of a large tumor which overlapped the patella. Such a mishap can readily be avoided by always keeping the knife-edge directed towards the growth. The incision itself should be lateral, so as to escape pressure, and, where possible, Packard's oblique incision should be tried. Whatever the treatment, a relapse may occur, the continuous pressure and friction to which the parts are subjected giving rise to a new bursa, which in turn may become enlarged. This is, of course, excessively rare.

PRE-TIBIAL BURSA.—Inflammation of this bursa gives rise to an ill-defined, small, tender swelling, which can be most readily felt on either side of the ligamentum patellæ, over the most prominent portions of the tibial tubercle. Sometimes the swelling can be felt more easily on one side than on the other. Enlargement of this bursa is quite common. It is more painful than that of the pre-patellar bursa, and interferes more with the movements of the knee-joint, owing to its being compressed between the tendon and the bone. The various measures suggested for acute bursitis, or even the actual cautery, should be tried. The disease is most commonly seen in rapidly-growing boys, about the age of puberty, and has been mistaken for osteitis. It often lasts for years, and interferes with exercise.³ Nothing should be attempted in the operative line, beyond aspiration, without the strictest antiseptic precautions, as the bursa sometimes communicates with the knee-joint. An unfortunate result occurred in two of three cases mentioned by Hamilton—two having been reported by Monro and one by himself. In one of Monro's patients, in whom the sac was opened by a valvular incision, supuration in the knee-joint occurred, necessitating amputation, while in another,

¹ Maunder, Clin. Lect. and Rep. Lond. Hosp., 1867-8, vol. iv. p. 258.

² See Section on Hygroma.

³ Barwell, op. cit., p. 490.

similarly treated, no good resulted. Hamilton's patient died after the introduction of a seton.

BURSA OF THE SEMI-TENDINOSUS, SARTORIUS, AND GRACILIS MUSCLES.—The bursa common to these, which may be prolonged between the tendons—or the separate sacs which are occasionally found between any two of them—may become enlarged. The French call these tendons the "*patte d'oie*." When suppuration occurs, tedious and troublesome sinuses sometimes result. This is one of the most commonly affected bursæ in tertiary syphilis.

POPLITEAL BURSAE.

Enlargements of these bursæ are of special interest to the surgeon, because they, even more than synovial herniæ, are apt to be mistaken for aneurisms. In fact, notwithstanding Mr. Bryant's assertion to the contrary, a recent writer of experience declares that, after all, the chief point of difference in certain cases is merely that the distensile impulse is not as powerful as would be expected in a thin-walled aneurism free from any deposition of clot. Still, with care such a blunder can be avoided. Suppuration in these bursæ has resulted in contraction of the knee from cicatrization. It will be well to first enumerate the bursæ normally present here. Special attention should be paid as to which do and which do not usually communicate with the knee-joint, as upon the answer to this question depends largely the nature of the treatment which should be pursued.

From their connection with the tendons, these bursæ are necessarily situated along the internal and external borders of the popliteal space. There are but two at the inner side of the ham. One, the largest, is situated between the inner condyle of the femur and the inner head of the gastrocnemius, together with the semi-membranosus, between which muscles it sends a process. It extends from the posterior inferior part of the internal femoral condyle to the back of the inner tuberosity of the head of the tibia, reaching even as low down as the upper border of the popliteus muscle. The outer border should not be detectable beyond the head of the gastrocnemius, while its inner portion extends beneath the tendon of the semi-membranosus. It is occasionally more or less subdivided into a moiety for each of these two muscles. After adult age it usually communicates with the knee-joint. The second internal popliteal bursa is found between the tendon of the semi-membranosus muscle and the internal tuberosity of the tibia, is obliquely situated, and is of small size. At times it communicates with the bursa previously described, and still more rarely, yet occasionally, with the knee-joint itself.

Externally, four bursæ are usually met with. One, which will be found between the popliteus tendon and the external lateral ligament, does not usually, although it may, communicate with the joint; a second, however, placed obliquely between the tendon of the popliteus and the external tuberosity of the tibia, does so communicate, being, in fact, but a diverticulum of the synovial capsule of the knee. In a large proportion of cases, this large bursa also opens into the superior tibio-fibular joint. The remaining two bursæ are by no means constant, although of frequent occurrence. One is situated above the head of the fibula, being interposed between the biceps tendon and the external lateral ligament of the knee joint. The external popliteal nerve runs along this bursa, a circumstance which may explain some of the pain experienced from its enlargement. The fourth and last is, when present, placed between the external condyle of the femur and the external head of the gastrocnemius. Its place is often taken by a prolongation of the bursa between the popliteus

and the external lateral ligament. Thus, of the six popliteal bursæ, one always communicates with the joint (the *sub-popliteus*); one generally does so (the *gastrocnemio-semimembranosus*); while a third does so occasionally, viz.: that between the external lateral ligament and the popliteus tendon.

Any occupations which demand prolonged muscular exertion, such as those of porters, soldiers, etc., undoubtedly predispose to enlargement of these bursæ, and in accordance with this fact they are of most frequent occurrence between the ages of twenty and thirty years. In a certain number of cases, the exciting cause also has clearly been over-exercise or a strain, but in most cases no special cause can be detected.

Symptoms.—These tumors are indolent, firm, elastic, of an ovoid form, and regular in their outlines, although in certain rare instances they may be lobulated or bosselated. They are little or not at all mobile, according to most authorities (McEwen, Foucher), although Erichsen gives mobility as a diagnostic mark. The superjacent skin is neither adherent nor discolored. They are usually of slow growth, and may lessen in bulk during rest in bed, but may rapidly develop, occasionally even in a few hours reaching the size of a hen's egg. This latter mode of development has been only noticed after some violent effort or extreme over-exercise. Tenderness is rarely complained of, even on firm pressure. A certain amount of stiffness and of dull pain is usually felt. Some patients experience frequently recurring attacks of cramp-like pain in the calf-muscles, especially after walking. When suddenly developed, or when a chronic swelling becomes rapidly enlarged, some tenderness on pressure may be felt for a time, but soon the tumor resumes its ordinary indolent condition. Fluctuation, according to Foucher, can be readily detected unless the sac-walls are much thickened, or when over-distension exists. This fluctuation can rarely be detected in the *extended*, but usually quite readily in the *flexed* position of the knee. This is a diagnostic point of the greatest importance.

The irregular, lobulated, or bosselated form, very rarely seen, is due to one or all of the following conditions. The tumor lying beneath the tendon may be constricted by it, especially when the muscle is tense; the bursal sac may be traversed by bridges, or partially divided into several compartments by incomplete partitions which render impossible its assuming the usual smooth ovoid form when distended by fluid; or its relations with the surrounding parts may be such as only to admit of easy distension at certain points. These tumors are ordinarily but slightly mobile, owing to their connection with the tendons. By the traction of the surrounding parts, a portion of the sac may become elongated, thus forming a pedicle, which will admit of these tumors changing their positions; again, actual rupture of the pedicle may occur, when a free unattached cyst will result.

As to the frequency with which they communicate with the joint, Foucher¹ shows that in 6 out of 12 of his cases, situated on the inner side of the popliteal space, the tumor was reducible; it was so in 1 out of 4 cases of those situated externally; while 2 out of 3 of the median cysts could have their contents emptied into the articulation. These latter, Foucher thinks, may have been synovial herniæ, although he expresses considerable doubt on this head. Joint effusion most commonly accompanies the median cysts, although not restricted to this class of cases. Foucher points out that error may arise from the apparent disappearance of the tumor when the joint is flexed; this can be avoided by deep pressure with the fingers, when the tumor, if not really emptied of its contents, can always be detected by careful manipulation. Coincident effu-

¹ Archives Gén. de Médecine, 1856.

sion into the joint is rare,¹ and may be primary or consecutive. There is usually no tendency towards cure, the best to be hoped for being a stationary condition of the tumor. Occasionally rupture occurs with a more or less permanent recovery.

Diagnosis.—Several other diseases having their seat in the popliteal region might possibly be mistaken for enlarged bursa. *Varix of the short saphena vein* may be simply mentioned in this connection. The *lymphatic glands* of the ham are occasionally enlarged, but rarely suppurate, and, in consequence, present no symptoms of fluctuation. They surround the artery more or less closely, and are much more liable to be mistaken for an aneurism than for a diseased bursa. Although some enlarged bursæ reach to the central line, they do not commence at this point, and usually in some position of the limb show elasticity or fluctuation. In the case of enlarged glands, inflamed lymphatics would almost inevitably be traceable, leading from some injury or sore into the popliteal space. *Suppuration beneath the popliteal fascia* would present more pain and constitutional reaction than a simple bursitis, unless it too had reached the stage of suppuration, when the conditions would be practically the same. A *cold abscess* would present antecedent morbid conditions not seen in cases of enlarged bursa, and would occupy no definite seat, such as one border of the ham. In addition, the subcutaneous tissue would, at some stage of the case, be œdematous and pit on pressure. A *malignant growth* would cause enlargement of the superficial veins, thinning and discoloration of the skin, an almost certain involvement of the neighboring lymphatic glands, with, sooner or later, infiltration of the surrounding tissues. If mobile and circumscribed at first, it would soon become fixed and blended with the neighboring parts. The only *benign growth* likely to be confounded with an enlarged popliteal bursa is a lipoma, and that probably only in the rare event of the enlarged sac being bosselated. A fatty growth would probably occupy no specially defined position in the ham, it would not have a sharply defined outline, and it would not become larger and more tense when the limb was extended. Again, the deep surface of the skin is frequently attached to a fatty tumor, which is never the case with a bursa, unless suppurating.

GASTROCNEMIO-SEMIMEMBRANOSUS BURSA.—This, as before said, is the largest and most constant of the popliteal bursa, and the one most commonly affected. Out of thirty cases of enlarged popliteal bursæ collected by Foucher, this sac was diseased in two-thirds. Usually no cause is assigned other than extra fatigue from walking. I am convinced, both from personal experience and from the cases published by others, that although over-exercise may be the exciting cause, rheumatism or gout is what renders it efficient. When this sac is affected, considerable dull pain will usually be complained of, with stiffness in walking. Occasionally, shooting pains extending down the leg may be felt. Although the patient will probably state that the knee is affected, nothing abnormal will be detected until the postero-internal border of the popliteal space is examined, when an oval, tense, firm, thin-walled tumor will be detected, over which the skin is freely movable, although the swelling itself is immobile. Its long axis may be oblique from above downwards and inwards, or longitudinal. In the former case the upper part of the swelling will reach the centre of the popliteal space, extending perhaps above the femoral condyle, while its lower part will reach to the inner side of the same region. When

¹ Median cysts which are often accompanied by joint effusion are of rare occurrence according to Foucher.

the swelling is of large size, these bursæ sometimes occupy the centre of the popliteal space. When tensely filled by the effusion, the tumor is usually large, in one reported case measuring 5 inches in its long diameter, and 3.5 inches transversely.

While the tumor is always tense in the extended position of the limb, it is less prominent, slightly elastic, and even occasionally fluctuating when the knee is slightly or perhaps semiflexed. When slightly flexed, in the event of the sac communicating with the joint, the fluid can be pressed into the inner portion of the articulation, which will bulge, although the patella may not be lifted from its normal position. When partially emptied, fluctuation can be detected, and the pulsation transmitted from the femoral artery, in one case reported by McEwen, ceased to be distensile, becoming merely heaving. Pressure upon the femoral artery and sac may possibly appear to slightly diminish the size of the tumor, but the passage of the fluid into the joint can then be detected. Pulsation and bruit are usually both present, the former often being of a distensile character. By more or less flexing the limb, the degree and character of this vary. When simply of a heaving character, the diagnosis is plain.

Diagnosis.—As this is the only normal bursa in this region liable to be mistaken for aneurism, its differential diagnosis only, from that affection, need be considered. This must depend upon the character of the pulsation, bruit, etc. If the pulsation be simply heaving, the case will be clear enough. If distensile, it will not be as energetic as that of a thin-walled aneurism should be.¹ While most distinct when the limb is fully extended, and when the patient is in the recumbent position, slight flexion will markedly diminish the pulsation, or cause its entire disappearance. This is almost pathognomonic. When so flexed, the tumor not uncommonly shows signs of fluctuation, and it in great part disappears.² Such a position would not, in any way, much less in the manner indicated, appreciably affect an aneurism, since, although extreme flexion might empty it and arrest its pulsation, slight bending of the knee would merely render the pulsation more evident and more under control. Complete extension makes the bursal pulsation marked, but renders that of an aneurism slightly less evident. Pressure on the femoral above the bursa arrests the pulsation, but does not reduce the bulk of the tumor, unless in the rare case where pressure on the bursal sac at the same time empties part of its contents into the joint, which then becomes distended either locally or generally. Again this emptying of the sac is impossible in most instances, except in one certain position, usually that of slight flexion. An aneurism can be emptied in any position. In one recorded instance, where distensile pulsation occurred with emptying of the sac by pressure, besides the bulging of the knee-joint, the sac remained empty for some time, until the patient walked. This is in marked contradistinction to that rapid filling of a thin-walled aneurismal sac, *pari passu* with each pulsation, which is so readily distinguished by the eye. The bursal sac can also be emptied as easily without as with pressure on the vessel.³ The upright posture, in one case of McEwen's, almost totally suspended the distensile character of the pulsation. No thrill has been observed in any reported instance, although having personally suffered from two enlarged bursæ in this region, my attention was first called to the disease by a distinct thrilling sensation in the limb, which led me to feel in the popliteal space, where, much to my surprise, I discovered a tumor. No such symptom, however, was detectable by palpation, but the pulsation was distinct in the extended, although not in the semiflexed position of the limb.

¹ McEwen, Glasgow Med. Journal, 1876, p. 468.

² McEwen, loc. cit.

³ Barwell, op. cit., p. 507.

In many cases the bruit is marked, but distant, not immediately under the ear, as would be the case in a thin-walled aneurism.

I have dwelt thus minutely upon the differential diagnosis of an enlargement of this bursa from aneurism, at the expense of some repetition, as it occasionally presents a puzzling problem not only to the tyro but to the experienced surgeon. Bryant reports a case of solid chronic enlargement of this bursa, which filled the whole popliteal space. It was movable, but, as the operation demonstrated, attached to the inner ham-string tendons. Its nature was not suspected, nor its attachments made out, until the incision was made. Mr. Bryant removed the bulk of the tumor down to its central cavity, which was of the size of a walnut, but left the deeper portions. Suppuration occurred in the knee-joint, necessitating amputation. Mr. Bryant confesses his inability to give the points necessary for a correct diagnosis, but records the case so that, others knowing that a solid bursal enlargement may occur in this locality, future errors may be avoided.¹

Treatment.—Aspiration, followed by firm pressure, with the limb kept quiet on a splint, seems to have proved successful in cases where any operation has been indicated. In many instances the removal of the cause, viz., over-exercise, and the internal administration of constitutional remedies, if gout or rheumatism is proved or suspected, with the inunction of compound iodine ointment, and rest on a splint, will prove amply sufficient. Firm pressure, following the use of blisters, also proves useful in certain cases.² As a constitutional remedy, I have been pleased with the action of the Buffalo Lithia Spring water, given persistently in large doses. Recorded cases where incisions into this bursa, as well as into the others which occasionally open into the articulation, have resulted in suppuration of the knee-joint, followed by amputation, and even by death, warn us that aspiration should be the most severe operative procedure resorted to. In the case of this bursa, as well as of other diseased bursæ in this region, the French surgeons have used injections of iodine, even when a communication with the joint has been known to exist, and without serious results, although some effusion into the articulation has usually taken place. The secret of this is that the injection—and this direction must be strictly adhered to—has been made with the limb strongly extended, in which position, as has been already shown, the opening is so perfectly occluded that no amount of pressure can force the fluid into the articulation.

BICIPITAL BURSA.—This bursa, when enlarged, gives rise to some pain and stiffness of the knee in walking. Over-use of the limb is the cause often assigned, but usually either a rheumatic or a gouty diathesis acts as a powerful predisposing cause. The bursa presents itself as a rounded, thin-walled swelling, situated at the outside and back of the knee, just above the head of the fibula, near the insertion of the biceps. The tendon of this muscle may be either felt gliding *over* the tumor, when the limb is alternately flexed and extended,³ or apparently the swelling embraces it.⁴ It is usually of a moderate size, but may reach that of a large apple. When the knee is flexed, the tumor is slightly mobile and fluctuating; while when the limb is extended, it is fixed and elastic, and does not fluctuate. Except when accidentally inflamed, it is not painful, nor even tender on pressure.

Treatment.—The joint should be kept fixed by an appropriate splint, when some form of counter-irritation, with pressure, or this latter measure with

¹ Op. cit., pp. 768, 769.

² See Section on General Treatment of Bursitis for more special therapeutic directions.

³ McKwen, loc. cit.

⁴ Lancet, vol. xlv. p. 74.

inunction of compound iodine ointment, should be resorted to. If this fails, careful aspiration, followed by counter-irritation, rest, and pressure, is the best treatment. For such cases as resist the above measures, perseveringly carried out, some of the other more radical plans mentioned under the head of Subacute or Chronic Bursitis may be tried. Acute bursitis must be treated, here as elsewhere, upon the general principles already laid down under the appropriate heading.

SEMI-MEMBRANOSUS BURSA.—Here, also, pain and stiffness of the joint are complained of. This bursa, when enlarged, takes the form of a circular—sometimes obliquely ovoid—tense, firm, slightly mobile, non-painful tumor of moderate size, situated at the inner and lower border of the popliteal space. It can hardly come into relation with the artery, and its diagnosis must depend upon the above characteristics and upon its situation.

Treatment.—Rest, with a splint if necessary, pressure after blistering, and in fact those measures suggested for the treatment of the other popliteal bursæ, must be tried.

POPLITEUS BURSA.—I am aware of only one case, recorded by Verneuil,¹ of enlargement of one of these sacs, but of which, seems doubtful. There was in this case also a so-called white-swelling of the knee. The tumor was removed by excision, and the case did well. A bursal tumor in the situation occupied by this sac would probably present the symptoms common to the other popliteal bursæ when enlarged, and should be treated very cautiously upon the principles already laid down, since, although it does not usually communicate with the joint, it may do so. The bursa *beneath* the popliteus tendon, between it and the bone, is, as has already been pointed out, merely a diverticulum of the synovial capsule of the knee-joint, and, in consequence, cannot become enlarged unless the joint also contains some effused fluid, or, either by its history or its present appearances, indicates the previous existence of some articular affection.

EXTERNAL GASTROCNEMIUS BURSA.—The bursa occasionally found beneath the external head of the gastrocnemius, has been in one instance reported as enlarged. There was an obscure, small swelling under the outer head of the muscle, which appeared suddenly during dancing or walking, sometimes compelling rest in bed and active antiphlogistic measures to relieve the agonizing pain, at others being relieved by a few minutes' rest in the horizontal posture. Pain was elicited on pressure, or when the calf-muscles compressed the tumor, either by standing on the toes or strongly flexing the foot. Rest and antiphlogistics, followed by blisters, firm bandaging, and a knee-cap, relieved, but did not cure, this case.²

Foucher describes some other bursæ occasionally found in this region, which are so unusual, and of such uncertain origin and symptoms, as not to warrant any special description. Their existence as well as that of the synovial cysts before cited as having been noted by W. M. Baker, should be borne in mind, as their presence may explain conditions found in certain cases, which could not be accounted for by enlargement of any of the normal bursæ of the part.³

¹ Mém. de la Soc. de Chirurg., Paris, t. ii. p. 369.

² Johnson.

³ I will here express my great indebtedness to the admirable papers of McEwen and Foucher, from which I have chiefly drawn my information, and to which I would refer those desirous of further details upon this interesting but much misunderstood and neglected subject.

BURSÆ OF ANKLE AND FOOT.

A bursal sac is, in tailors, usually developed over both the internal and the external malleolus, especially the latter; one is situated between the os calcis and the tendo Achillis; another on the plantar surface of this bone, over or in front of the tuberosities, beneath the fascia there attached; one on the inner and outer sides of the plantar surface of the metatarso-phalangeal joint of the great toe;¹ one under the plantar surface of the head of the fifth metatarsal bone; another, occasionally, on the plantar surfaces of any or all of the other metatarso-phalangeal joints; one on the dorsal surfaces of the inter-phalangeal joints; one on the dorsum of the foot; another over the tuberosity of the scaphoid; one over the projecting styloid-process of the base of the fifth metatarsal; one over the projecting portion of the head of the astragalus, in patients with flat foot; and others in various situations in cases of club-foot.

RETRO-CALCANEAN BURSA.—Enlargement of this sac is a very rare affection, but as it occasionally simulates disease of the ankle-joint, I have thought it worthy of a special description. Its anatomy differs somewhat from that of other bursæ, in that cartilage forms part of two of its walls, viz., the anterior and posterior, for the vertical portion of the os calcis beneath the tendo Achillis, and the portion of this tendon which faces that part of the bone are both coated with a thin layer of cartilage. This bursa is small and heart-shaped, with its apex upwards, thus forming two pouches, one on each side of the tendon. These lateral pouches have a few bridles of connective tissue traversing them, although not of enough bulk to form even partial partitions. A vascular and fatty fold is usually found in each pouch. Constitutional causes are commonly at the bottom of enlargements of this bursa, although over-exercise by exaggerating the movements of the part is usually the sole cause which is recognized. Traumatism, other than the rubbing of an ill-fitting boot, can hardly ever be a cause, owing to the protected position of the bursa.

Symptoms.—The depression on each side of the tendon is effaced by a fluctuating tumor which elevates it. Local pain and tenderness are complained of, and, when suppuration occurs, heat and redness of the skin are present. Unless there is suppuration, spontaneous pain is rare. Flexion and extension of the foot, either passive or during attempted walking—which is difficult if not impossible—give rise to severe pain in all cases, whether suppurative or not. Contraction of the calf muscles causes more or less acute pain, by making traction on the tendons. In other respects the symptoms resemble those of other inflamed bursæ. Suppuration is not an uncommon sequence, but resolution also occurs, especially in the purely constitutional cases. When the pus is spontaneously evacuated, rest and methodical compression rapidly effect a cure. From its propinquity to the os calcis and the ankle-joint, periartritic abscess, caries of the calcis, etc., are liable to occur.

Diagnosis.—When the case is seen at the outset, the diagnosis presents no difficulties, but after the formation of pus, some obscurity may arise. The diagnosis must mainly depend on the presence of a fluctuating tumor, before pus could have formed in sufficient quantity to present this symptom; on its limitation to the known site of the bursa; on the local pain produced by

¹ A. Lenoir (Presse Médicale) says that there are two sacs here: one normal, on the plantar surface; the other, which is accidental, over the side of the head of the metatarsal bone. The plantar sac is found in the fœtus at term, and, strange to say, is relatively larger in the child than in the adult.

flexion and extension, and above all by the voluntary contraction of the calf muscles; on the existence of tenderness on pressure over the tendon; and on the absence of any effusion in the tibio-tarsal joint, which would be shown by swelling in *front* of this articulation. A careful comparison of these symptoms with those of an abscess in this region, or caries, should render the diagnosis possible, although difficult.¹

Treatment.—This does not differ from that of similar affections elsewhere, but the surgeon must bear in mind the frequency with which the disease depends on gout or rheumatism, so that the proper constitutional treatment may be instituted.

McEwen has described a peculiar affection of the plantar surface of the ball of the great toe, which is evidently bursal. With no history other than that of extreme fatigue from much walking, the patient complains of a chronically painful condition of the part, which interferes with locomotion often to the extent of rendering progression impossible, except by treading upon the outer side of the foot. But little swelling can be observed, and no other symptom except tenderness on pressure. There is not the slightest sign of inflammation, as in bunions. After a long time, in certain cases, a slightly greater fullness over the tender part, with obscure fluctuation beneath the deep plantar ligaments, may be observed. On two occasions McEwen resorted to puncture, giving vent to a synovial fluid. Rest, the use of fomentations, and puncture in extreme cases, have resulted in palliation, but not in cure. This affection must not be confounded with bunion, a description of which follows.

In conclusion, I will say that bursæ have been observed in the following situations, viz., between the end of the bone and the cicatrix, in stumps; over the surface of subcutaneous tumors; over the outer surface of the latissimus dorsi muscle; in the thickness of the labia majora, in women who abuse coitus; at times beneath cicatricial bridles, etc.

I have endeavored to make this list of bursæ and their affections as complete as possible, but, having had to collect my data from very many scattered sources, may have overlooked some few. Finally, I may add that any peculiar habits, use of special instruments, peculiar trades, etc., may give rise to other bursæ whenever the circumstances are favorable for their formation.

BUNION.

A bunion may be defined as an irritated, and consequently enlarged, bursa, situated over one of the tarsal, metatarso-phalangeal, or inter-phalangeal joints, which is distorted. This bursa may be normal or adventitious. The superjacent skin is commonly the site of a corn, or at least is much thickened. Indeed, some authorities state that a bursa is invariably present "in all old and neglected cases" of corn.²

Bunions are usually developed over the metatarso-phalangeal joints of the great or little toes. The affection is generally induced by the wearing of improperly shaped shoes, which tend to draw all the toes, but especially the great toe, towards the central axis of the foot. If, in addition, the shoe is too short and high-heeled, distortion is still more favored. Indeed, a shoe of this

¹ The dull aching pain at the back of the heel, experienced occasionally by adults, but more commonly by children from five to fifteen years of age, and increased by exercise, Barwell thinks is due to inflammation of this bursa.

² Bryant, *op. cit.*, p. 145.

kind, even though properly shaped, is of itself an efficient factor of bunions. The normal long axis of each toe coincides with that of its metatarsal bone, and this, if prolonged, passes through the centre of the heel, so that normally the great toe points slightly inwards rather than outwards. The toes should spread when the weight of the body rests upon the foot, the contiguous borders of the first and second being separated by a distinct interval, the second and third closer together, but not in contact, while even the third and fourth do not usually touch. If, then, the digits be confined at their distal ends by a narrow-toed shoe, the weight pressing down an inclined plane, as where high heels are used, the foot will spread at the only possible point, viz., at the metatarso-phalangeal joints, and that of the great toe will form a salient angle inwards. The other toes are then compelled to assume different degrees of flexion, or of flexion of one joint with extension of others, thus favoring the formation of bunions over the salient angles. The skin over the projecting joints becomes thickened and corneous; the bursa, normal or adventitious, is enlarged; and a bunion is fully formed.

Aston Key explains the distortion of the great toe in the following manner: In the young and weakly, by prolonged standing or walking, the anterior tibial muscle, upon which chiefly depends the maintenance of the pedal arch, becomes weakened, and in consequence the anterior segment of the foot tends to rotate outwards. This, through the abnormal position of the astragaloid head, throws the weight upon the inferior calcaneo-scapoid ligament, which yields. The patient thus becomes flat-footed, and from the rotation outwards of the anterior segment of the foot, the weight is borne on its inner plantar surface, and this gradually forces the great toe obliquely outwards. This explains why the lower classes often present the worst forms of bunion, since, although not wearing tight shoes, they do wear those which are short and badly formed, and are compelled to stand continuously.

The tendency to the formation of bunions is sometimes hereditary; and in such individuals, even properly constructed shoes often fail to avert the disease. Bunions are unknown among the savage races who wear no foot coverings.

The first sign of a bunion is a tender spot over one of the joints which has suffered some degree of distortion, so as to render the articulation salient. Soon the part enlarges from effusion into the normal bursa there situate, or by the formation of an adventitious sac. The disease may now remain stationary, and the patient may suffer no other inconvenience than occasional twinges of pain. Commonly the bursa does not suffice for the protection of the deeper parts, and is subject to recurrent attacks of inflammation, which are characterized by violent, throbbing pain in the affected part, with marked heat, redness and swelling of the integument. The bursa then becomes distended with serum, and, if the inflammation is not checked at this stage, suppuration results, and troublesome ulcers are left, which are not uncommonly the starting-points of senile gangrene. The pus does not always remain confined to the bursa, but is infiltrated into the surrounding tissues. Marked constitutional symptoms are present.

Certain changes which have been thought the result of bad bunion, such as enlargement of the head of the metatarsal bone, the formation of exostoses around its margin, frequent absorption of the cartilage, with an eburnated condition of the subjacent bone, etc., are in all probability the result of rheumatoid arthritis. Other changes, which it is important to note, and which are undoubtedly due to the distortion, are a lengthening of the internal lateral ligament, and a corresponding shortening of the external. This is so marked that, according to T. Smith, the rupture of the latter ligament takes place even in the dead body before the distortion can be overcome. The extensor tendon of the great toe is luxated outwards to a variable

extent. The tendons of the flexor brevis and adductor are likewise situated more externally than natural.

TREATMENT OF BUNION.—From what has been said as to the causes of bunion, it is clear that above all things the treatment should aim at the removal of pressure. This end can be best attained by wearing long, "easy" shoes, taking care, however, that they are sufficiently tight over the instep, to prevent the toes from reaching their extremities, as otherwise the looseness will but add to the evil. The inner border of the toe portion of the sole, which must be as wide if not wider than the foot part, ought to be straight, as in the so-called "waukenphast" shoe. "Boxtoes" are also valuable where the smaller digits are distorted. Until the deviated axes of the toes are restored to their normal line, the projecting angles formed by the distorted joints must remain exposed to irritating pressure. When the great toe only is involved, a separate compartment for it in the shoe is the simplest measure to effect a restoration of the deviated axis. The following apparatus should be worn at night: A band of stout linen or light canvas fitted to the tarsus and metatarsus, arranged so as to lace firmly on this portion of the foot, should be provided. Upon its inner side a narrow "casing" should be made for the reception of a piece of spring-steel about half an inch wide, curved in a sigmoid manner so as to fit the concavity of the tarsus and metatarsus by its convexity, while by its concavity facing towards the metatarso-phalangeal joint, pressure is avoided.¹ The joint must be protected by soap-plaster spread on amadou or soft felt. Lacing the band on, and placing the piece of steel in its casing, all that is now required to complete the dressing is to slip a broad rubber band, of such thickness and length as not to produce pain, around the toe and the projecting distal end of the bar. Even as a permanent dressing for the daytime, this simple little apparatus is to be recommended, being quite as efficacious as Bigg's or Sayre's, besides being readily made at home, or at the most requiring the aid of a blacksmith.

The use of one of these devices may prove successful even in the more severe cases. In these latter, if obstinate, subcutaneous section of the external lateral ligament, or of the tendons of the adductor or flexor brevis pollicis, or of all three, may be resorted to advantageously.

When any but the great or little toe is the one affected (as in the deformity known as "hammer-toe"), the simple expedient of passing a strip of adhesive plaster about an inch wide, first *over* the distorted toes and then *under* the normal ones, will often suffice to cure the deformity. Of course the unspread surface must be laid upon the distorted toes, so that the adhesive surface may be applied to the normal ones, which serve to pull the deformed toes into place.² Where either incipient or pronounced "flat-foot" is detected, anything like prolonged standing must be strictly interdicted. A steel shank should be fixed in the sole of the shoe. The enfeebled muscles must be stimulated by friction, massage, or electricity, and where these do not avail, a piece of rubber tubing should be employed, after Barwell's method, to aid the weakened muscles in maintaining the proper form of the foot.³

As palliatives and adjuvants, the careful removal of the thickened epidermis, and the protection of the sensitive parts by means of soap plaster spread upon leather, either in the form of a ring to remove pressure, or as a continuous covering, should be tried. These means, with proper shoes, rest and emollient applications for a few days, followed, when the inflammation is

¹ A piece of corset-steel will do in an emergency.

² Ashton, Med. Times and Gaz., 1852, N. S. vol. v. p. 282.

³ See Sayre, Orthopædic Surgery, pp. 84, 85.

entirely gone, by painting with tincture of iodine, a simple blister, or an ointment of the biniodide of mercury (gr. x to 3j), will frequently cure the milder cases where only slight distortion is present. If there is much fluid present, with no attendant inflammation, subcutaneous puncture and discission of the sac, followed by pressure, with or without the use of iodine externally, is good practice.

When the bunion is acutely inflamed, rest in the horizontal posture, with the foot elevated, and the application of an anodyne water-dressing, constitute the best treatment. If suppuration ensue, an early and free incision should be practised. Some caution must be exercised as to incisions in the aged or ill-nourished, in whom gangrene or serious suppuration not infrequently occurs. Cæsar Hawkins finds that even when the bone is laid bare by a suppurating bunion, a cure can often be effected by the use of nitric acid. He removes the superjacent corn as freely as possible, enlarges the orifice of the bursa, and cautiously applies the acid once or twice. When the disease is close to a joint, great caution must be exercised. If the bone be denuded, it should be touched freely but carefully with the acid. This will promote the separation of the necrosed portion, when the bone will probably become covered with healthy granulations.

Stimulating applications, such as resin cerate, etc., with opium and stimulants internally, are safer, when indolent, suppurating sores remain, than laying open the sac. In the young or middle-aged, but only as a last resort, the bursa may be laid open or excised, but, if possible, only with antiseptic precautions. Occasionally the suppuration extends to the adjacent joint, resulting in its destruction, with more or less extensive caries of the bones. If, after a fair trial of rest, free drainage, and appropriate dressings, a cure by ankylosis does not result, I strongly advise amputation through the metatarsal bone, my experience leading me to an unfavorable opinion as to excision of the diseased joint, although this operation has been successfully practised by Kramer, Pancoast, and others.

PERFORATING ULCER IN ITS RELATIONS TO BUNION.

In studying the literature of this strange affection, it is evident that there is more than one variety of the disease. I have myself no doubt that at least two of its forms are at the outset etiologically the same, though when seen during their later stages it is exceedingly difficult to believe them identical affections. Undoubtedly the course pursued in various cases is due to the difference in the resisting and reparative powers of the patient's tissues. There is certainly no greater variation exhibited by this disease than all surgeons are familiar with in slight injuries of a joint. In a healthy, robust individual, a slight blow or sprain is readily recovered from, while in one who is feeble, sickly, or, though apparently healthy, of a strumous diathesis, a slow form of inflammation is set up, which eventuates in the destruction of cartilage and bone, or perhaps even the patient's life, if relief by art be not afforded. The dependent position of the foot, and its necessary use as an instrument of support and means of progression, render active a latent tissue-defect or constitutional weakness, which elsewhere would escape detection. Whether a third form of perforating ulcer, of the nature of a neurosis, exists or not, it seems in our present state of knowledge impossible to decide absolutely. When describing the symptoms of the several varieties of the disease, I shall endeavor to determine this matter, or at least to give the facts observed, so as to enable the reader to arrive at an intelligent conclusion.

(1) As has been already said, most authorities state that under all neglected

corns, a bursa, or at least a bursal space in the connective tissue, is developed. If from constantly recurring irritation suppuration takes place in this bursa, the pus must fail to reach the surface through the thickened corneous epiderm. Seeking then the point of least resistance, it will eventually open upon the dorsum of the foot. A probe passed through the sinus will impinge upon the plantar corn, which may or may not be traversed by a small opening. In the perfectly healthy there will usually be no disease of any of the joints or bones of the foot. The *treatment* is simple, consisting in rendering drainage efficient by enlarging the plantar opening, and in exciting the callous walls of the sinus to adhesive inflammation by the introduction of a fine silk seton. (2) The second variety, depending as I have already said chiefly upon individual idiosyncrasy, is a much more serious disease, eventuating in a more or less complete destruction of the member, and sometimes even in loss of life. As will be seen hereafter, I know of no means of distinguishing it from (3) the neurotic variety, except by the absence of anæsthetic symptoms, and I shall accordingly describe the two affections together.

SYMPTOMS.—Perforating ulcer (*mal perforant du pied*) was first described by Cloquet, in 1837, and has since been studied by Boyer, Marjolin, Vesigné, Wilks, Péan, Desoul, Masbrenier, Hancock, and numerous later writers. As a rule, it commences in the young, is hereditary, and of long duration, being characterized by a series of attacks alternating with apparent recoveries. Most authorities—Nélaton being the chief dissentient—agree in describing the disease as commencing by the formation of hard plantar corns. These are usually situated over the heads of the metatarsal bones of the great, middle, or little toes, although other parts may be the sites of these callosities.¹ Coincidentally with the appearance of the corns, offensive sweating of the feet occurs. Suppuration next takes place, the skin gives way, and in the course of five or six weeks, if the resulting sinus be examined by a probe, bared, necrosed bone will be easily detected, which sooner or later separates—to be removed by art or nature—when a temporary convalescence results. When first seen by the surgeon, nothing will perhaps be found but a hard callosity over one of the metatarso-phalangeal joints, having at its centre a brownish depressed spot. This, on closer examination, shows itself to be a perforation giving vent to sero-pus. Subsequently the foot becomes slightly brawny and swollen. In certain cases, anæsthesia of the opening, and of the surrounding skin, with lowered temperature, will be detected. In others, severe pain in the heel and ankle is complained of. At a later period the tendons become affected, distorting the toes; the nails become yellow and fissured, perhaps laterally twisted; epidermal accumulations form upon the dorsal as well as on the plantar surfaces of the foot, and the integument becomes pigmented. Both feet may be involved, and even the hand has been seen affected by a similar disease. The anæsthesia may extend even above the knee. Nélaton describes the disease as always commencing by phlyctenulæ, which contain pus. These breaking, the true derm, of a rose color and exquisitely sensitive, is laid bare and soon ulcerates. In all other respects Nélaton's account of the disease is identical with that given by Vesigné, Hancock, and others.²

The fact that the disease commonly occurs in strumous cases supports the opinion which I have already given as to its nature in the majority of instances. Wilks considers it to be strumous; Vesigné regards it as a variety of plantar psoriasis. The view that it is due to atheroma, etc., was disproved by Masbre-

¹ Vesigné states that it commences as a bunion, or as a flat corn, with thickening.

² Vesigné explains this discrepancy by showing that Nélaton saw cases at a later period of the disease, when, as in several of his own cases, phlyctenulæ were the starting-point of *secondary*, though never of *primary* attacks.

nier and Picot, who demonstrated that it occurred in those whose vessels were even microscopically sound. Doubtless, however, where atheroma or endarteritis exists, it is a factor in the development of the disease. Poncet, in 1864,¹ Duplay and Morat in 1873,² Savory and Butlin in 1879,³ and other writers, have demonstrated a thickening of the endoneurium of the nerves of the part, resulting in partial destruction of the nerve-fibres. Some of these writers consider these changes to be secondary to the ulceration, while others, especially Messrs. Savory and Butlin, believe that they are the cause of the disease, and that the sensory and nutritive fibres mainly suffer, while the "motor fibres escape owing to their larger size and thicker medullary sheaths."

As before said, I believe that there are probably three varieties of perforating ulcer, viz.: (1) one arising from a suppurating bursa beneath a corn in healthy subjects, and without subsequent bone disease; (2) a second, arising as the first, but in subjects of a strumous or broken-down constitution, and ending in extensive destruction of the bones, etc.; and (3) a third, where there is either primarily, as is most probable, or secondarily, disease of the nerves, which is accompanied by anæsthesia of the parts. My reasons for not thinking that all severe cases of perforating ulcer are due to a neurotic element, have been partially given already, but I shall now present a few other reasons, as briefly as possible. Not all cases of this disease are accompanied by anæsthesia, but some on the contrary are painful. The disease is limited to the anterior segment of the foot. A Pirogoff or Syme amputation is almost invariably successful, though such an operation only insures that the integuments of the stump are such as are tough and habituated to pressure, while they can produce no more effect upon a nerve lesion than partial amputations through other portions of the foot, which latter, however, fail, because ulceration from pressure, etc., soon arises in the abnormally placed and comparatively tender skin which in them forms the flaps at the joints pressed upon; the anæsthesia may extend to the knee, yet after a Syme or Pirogoff amputation the disease does not usually recur. Finally, the view that this disease is caused by the atrophy of the sensory and trophic fibrils is purely theoretical, especially in view of the great doubt as to whether the latter exist at all. Upon the other hand, similar ulcerations have been observed in cases of locomotor ataxia, anæsthetic leprosy, and progressive muscular atrophy, and in cases of compression of nerve trunks; and I would suggest that certain of the so-called cases of perforating ulcer should—and would, if the patients were more carefully examined—be classed among the mild and obscure cases of some of the affections just mentioned. I do not deny that there may be a neurotic form of perforating ulcer, but believe that the affection is not invariably of that character, and that in the present state of our knowledge we cannot say positively what share the altered nerves have in producing the disease.

I may now briefly recapitulate the distinctive features of perforating ulcer, which render it difficult to confound with any other disease, even with that most resembling it, the so-called tubercular disease of the foot. (1) It commences by corns under the metatarso-phalangeal joints; (2) It is confined to the anterior part of the foot; (3) There is offensive sweating of the foot; (4) There is no evidence of tubercle; (5) There is only moderate swelling; (6) The disease—or rather the tendency to it—is hereditary.⁴

¹ Rec. de Mém. de Méd. de Chir. et de Pharm. Milit., 1864.

² Archives Gén. de Méd., Mars, Avril, Mai, 1873.

³ Medico-Chirurgical Trans., second series, vol. xlv. 1879, pp. 373-393, with plates.

⁴ See Hancock on the Anatomy and Surgery of the Human Foot, 1873, pp. 59-76; also Nélaton, Gaz. des Hôpitaux, Paris, Jan. 1852; Vesigné, loc. cit., Fév. 1852, and the other authors mentioned in the body of this section.

TREATMENT OF PERFORATING ULCER.—Of course all that will improve the general health is advisable, and one medicine vaunted by Vesigné should be tried in small doses, although probably useful only as a tonic, viz., Fowler's solution. As a palliative, the use of an artificial limb applied to the flexed leg, has been recommended, as removing pressure and irritation. When no operation is advisable, or possible, it should be tried. When operative interference seems indicated, I consider it of prime importance to ascertain if anæsthesia of the skin be present. When this is marked, the operation should at least remove the portion of the member which is anæsthetic. If the sensibility of the leg is much affected, and the patient's general condition is not good, an amputation just below the knee would probably give the best result. When the sensibility of the heel is preserved, a Syme's, Pirogoff's, or sub-astragaloid amputation should be resorted to. This is usually found effectual in staying the further progress of the disease, as this is, almost invariably, strictly limited to the anterior segment of the foot. When, on the other hand, no anæsthesia is present, and the disease is limited, a mere removal of the necrosed portions of bone, attention to the general health, and appropriate dressings will usually prove effectual. By attention to these rules I think that, upon the one hand, no unnecessarily severe measures will be resorted to, and that, upon the other hand, when an operation is undertaken, it will not have to be repeated.¹

¹ I would here express my indebtedness to Mr. Ralph W. Seiss for much valuable aid in making notes and abstracts of cases, which have greatly aided me in the preparation of this article.

INJURIES AND DISEASES OF NERVES.

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THE different varieties of nerves (spinal nerves, cranial nerves, great sympathetic nerve) may be affected by the same lesions, which give rise to symptoms differing with each variety. In the case of the cranial nerves, the symptoms vary with each nerve, in consequence of its special function; therefore a general study of their lesions cannot be made. But this is not so with the spinal nerves, for whatever nerve is affected, the primary and secondary symptoms are always the same.

The general considerations which follow, relate, therefore, only to spinal nerves. The history of the lesions of the other varieties of nerves belongs to regional pathology.

We will successively consider: (1) Traumatic lesions of nerves, in connection with which will be given an account of the process of repair of nerves after wounds, and of the functional and trophic disturbances secondary to injuries of these organs; (2) Inflammatory lesions of nerves; (3) Neuralgia; (4) Tumors of nerves, and the affection known as painful subcutaneous tubercle; (5) Tetanus, in which disease the nervous element plays so important a part; and, finally, (6) The various operations which are practised upon nerves.

TRAUMATIC LESIONS OF NERVES.

The primary and secondary symptoms of traumatic nerve lesions are pretty much the same as regards their nature, in the different injuries. But they differ in their intensity, their acuteness, their dissemination, their duration, and the greater or less simultaneousness of their development, according to the nature of the lesions. Therefore a general study of traumatisms of nerves is not sufficient. It is essential to examine each of them successively, pointing out the special symptoms in each case, and referring to a special section for the complete study of each of these symptoms. This method of proceeding will permit us, moreover, to give in connection with the several varieties of injury, the indications for immediate treatment applicable to each.

We may, with Tripier, divide traumatisms of nerves into two principal

groups, according to whether there is or is not a wound of the integument. But this division is not justifiable in every case, for lesions of the nerves which may occur without a lesion of the integument, may also exist when there is a wound of this structure.

We will consider: (1) Concussion, compression, contusion, and crushing; (2) Stretching and avulsion—these lesions may occur without a wound of the integument; (3) Punctures, cuts, contused and gunshot wounds, and wounds attended with lodgment of foreign bodies, in connection with which the ligation of nerves will be referred to; and (4) The phenomena consecutive to injuries of nerves, which are found to present certain differences in each variety of wound.

I. CONCUSSION, COMPRESSION, CONTUSION AND CRUSHING OF NERVES.

CONCUSSION.—We will first consider briefly *concussion* of nerves, under which head were formerly placed all those functional lesions of the nerve trunks which were unaccompanied by any appreciable anatomical change. Formerly, cases of slight and indirect contusion were referred to this condition, and through its mechanism were explained the disturbances frequently observed in the functions of the nerves in the neighborhood of that which had been wounded. At the present day, however, the progress made in pathological anatomy and physiology has restricted the field of concussion. It may continue to be described as a clinical type, but the attempt is made to connect it with anatomical alterations, as yet, it is true, but little understood. The most probable lesion of concussion, according to Tillaux, is a disintegration, or momentary coagulation, of the medullary substance of the nerve.

COMPRESSION OF NERVES.—*Rapid Compression: Pathological Anatomy and Physiology.*—Rapid, sudden, or acute compression is to be distinguished from that variety which occurs slowly. The former is usually manifested by very intense pains, and its mechanism presents close analogies to that of contusion. Slow compression, on the contrary, occasions nutritive alterations, particularly in the muscles, without sensory phenomena of any description.

Vulpian and Bastien have experimentally studied rapid compression; they describe two periods—one of *increase*, which is limited by the duration of the compression, the other of *decline*, which comprises the phenomena consecutive to the compression. Each of these periods includes four stages. In the first period there are: (1) A stage of tingling and formication with a sensation of heat and cramps: this stage lasts from two to ten minutes; (2) An intermediate stage, or that of remission, which lasts from a few seconds to a quarter of an hour; (3) A stage of hyperæsthesia of the skin only; and (4) A stage of progressive anaesthesia, sometimes with persistence or exaggeration of the pain, and vague and paroxysmal pains in the muscles, which at first experience a feeling of fatigue, and which subsequently are paralyzed. In the second period there are: (1) A stage of paralysis, without deep pain, continuing two or more minutes; (2) A stage of reappearance of the muscular function, and then of sensibility, except the sense of temperature; (3) An intermediate stage, with more perfect return of sensibility and movement; and (4) A final stage, marked by a sensation of cold and weight, general malaise, nervous crethism, muscular spasms, and formication, with a reappearance of sensibility to temperature.

The experiments of Waller and the labors of Weir Mitchell have essentially confirmed the preceding results, the differences relating only to the

ineconstancy of the intermediate stage, the diffusion of the muscular paralysis in the zone of neighboring nerves, and, finally, to the fact that if the compression is neither intense nor prolonged, sensation rapidly returns, while in the contrary condition several days may elapse before it is re-established.

According to Weir Mitchell, who has endeavored to determine the force necessary to abolish nervous conductivity, compression acts solely in a mechanical manner. He has found, in the animals upon which he has experimented, some traces of congestion, and especially a change in the state of the contents of the nerve-tubes resembling that seen in nerves which have been divided for seven or eight days; and it is to these disturbances that he attributes the loss of sensation. But these lesions still continue to exist when sensation has reappeared, and it becomes necessary, therefore, to look for another cause, which is probably, as maintained by Tripier, a disturbance of the circulation. In conclusion, it is seen that the mechanism of the lesions of compression has not as yet been thoroughly elucidated.

Etiology.—Compression of nerves may be due to two sets of causes: traumatic causes and inflammatory lesions.

(1) *Traumatic compression* may arise from an unnatural position during sleep, as in the radial paralysis termed rheumatismal, which is always, according to Panas, due to a direct compression of the nerve by the head, or by a resisting body, such as the back of a chair; it may also be due to the pressure of a band, or fetter, or even to the pressure of the bridal-rein against the third finger, in the case of horsemen after prolonged marches; to the pressure from the handle of a basket or bucket (paralysis of the water-carriers of Rennes), or from the head of a crutch pressing upon the brachial plexus, or to the compression produced by the forceps or foetal head upon the nerves of the pelvis. In the foetus, traumatic compression, usually of the facial nerve, has been described by Dubois and Noisier, ordinarily caused by the forceps, but sometimes due to a malformation in the pelvis of the mother, or even to the sacro-vertebral angle. Finally, some authors admit also the accumulation of fecal matter as a cause of compression of the lumbar plexus of nerves, and the compression of nerves by contracted muscles. But the disturbances observed in the latter case seem to be more connected with venous stasis, and the pains which at times occur in the posterior region of the thigh after the evacuation of scybala, appear to be reflex pains, due to the exaggerated distension of the intestinal walls. In these cases, when a lumbar pain is present, it is more likely due to localized peritonitis than to nerve compression.

(2) *Compression from inflammatory lesions* is most frequently due to a neighboring inflammation; the compression is here produced by the vascular dilatation and infiltration of plastic products around the nerve, without any change in the interior of the nerve itself, beyond a passive hyperemia.¹ The pain is much more acute in affections of the osseous tissues, which are not extensible, than in the soft tissues. But, moreover, according to Tripier, the nerve element is directly influenced by the disturbances of the circulation which occasion the hyperæsthesia. This writer believes that the interference with the circulation plays the principal part in the compression of nerve fibres by retractile cicatrices.

Then, too, a nerve may be compressed by callus, whether or not it is involved in the mass of the latter. In this case it is still a secondary inflammation which causes the pain. A healthy nerve may be inclosed by callus, without being either compressed or painful.

Symptoms.—For the symptoms which occur in cases of *slight compression*,

¹ The compression of nerves in inflammation explains the relief which follows when the inflamed tissues are incised.

it is sufficient to refer to the results of physiological experimentation already quoted, bearing in mind the differences which always exist in pathological cases.

The first symptom in *severe compression* is the pain, which generally occurs immediately, and extends throughout the entire territory to which the injured nerve is distributed; it may continue several hours or even days, accompanied or followed by formication, hyperæsthesia, numbness, and finally motor paralysis, which may also occur at the outset when the compression is sudden and violent, or when it is produced during sleep, as, for example, in the case of radial paralysis. There is also met with, but less frequently, a more or less complete loss of general or spinal sensibility. After a variable period, the pain, formication, and paralysis successively disappear, sensation returning simultaneously with or before the power of motion. If the compression has been sufficiently severe, this period of reparation may be preceded by a slow atrophy. A constant sensation of cold in the paralyzed part has also been observed, being met with especially in the severe cases. The electro-muscular contractility, according to Guénot, may be abolished, diminished, or intact.

In the compression of nerves caused by the head of the crutch, studied by Laféron and by myself, the numbness and paralysis progress from the distal extremity of the limb towards its proximal end; their course is usually slow, but the paralysis may occur suddenly after a violent effort, and it is almost always only in the territory of the radial nerve that these disturbances occur; in these cases there is at times paralysis of the sensitive fibres of the nerve, the condition differing in this respect from the so-called rheumatic radial paralysis. The nerve next most often compressed by the crutch-head is the ulnar. This variety of paralysis, however, is seldom grave; and Laféron reports only one case of secondary atrophy, and that occurring in a child which presented some doubtful signs of infantile paralysis.

Slow compression of nerves may be produced by the development of tumors, especially of malignant tumors which involve the cellular sheath, and undergo secondary contraction. The nerve-fibres may also be compressed by the development of a tumor in the thickness of the nerve (neuroma). But the most frequent causes of this variety of compression are seated in the spinal canal, and consequently act upon the roots of the nerves. These are tumefactions, either meningeal (sarcoma, psammoma, echinococcus, internal pachymeningitis), or extra-meningeal and developed in the cellulo-adipose tissue of the canal (carcinoma, sarcoma, hydatid cyst, abscess), or finally vertebral (Pott's disease, cancer of the vertebræ).

The peculiar *symptoms of slow compression*, according to Tripier, are nutritive changes, affecting especially the muscles, without sensory phenomena of any kind; but clinically they are almost always accompanied by the symptoms of neuritis, or, at least, of nerve irritation, determined by the prolonged compression. When the cause of the compression is seated in the spinal canal, the cord is more or less rapidly affected; but generally the symptoms of nerve compression show themselves first, and remain isolated for a certain period before the appearance of symptoms referable to the medulla.

Compression of the nerve-roots manifests itself by three kinds of phenomena: pain, paralysis, and trophic disturbances. The *pain* is peripheral, and affects the territory supplied by the compressed nerve, constituting pseudo-neuralgia. It is usually permanent, with exacerbations, caused especially by movements. This pain may be accompanied with hyperæsthesia of the skin, particularly at the beginning. At a more advanced period the painful anæsthesia of authors

(*anæsthesia dolorosa*) is met with. It consists of an insensibility of the skin, with persistence of the spontaneous pains. *Paralysis* is not a constant symptom of slow compression; it is particularly rare to find it accompanied by contractures. The *trophic disturbances* are analogous to those met with after wounds of nerves; those most frequently seen are herpes zoster, bullous eruptions, at times gangrenous patches, joint affections, and, finally, muscular atrophy, which may exist without paralysis. Trophic disturbances of the eye have been noticed in cases of compression of the trigeminal nerve by an intra-cranial tumor.

In this triad of symptoms—pain, paralysis, and trophic disturbances—the influence of the inflammatory process must not be forgotten. It is to it, probably, that are due the pain and the rapidity sometimes observed in the evolution of the paralysis and trophic disturbances. Indeed, slow compression may occur without sensory phenomena, while the trophic and functional disturbances which it produces may have an insidious course, and for a certain time remain unrecognized, not attracting attention until the occurrence of some accident or disease which is apt to be considered as their sole cause. Weir Mitchell cites, in this connection, the very interesting case of a little boy who limped in walking, and whose lameness was attributed to a recent fall, while in fact it was due to an old typhlitis which compressed the nerves in the pelvis, and had already caused a noticeable atrophy of the muscles of the lower extremity. Unfortunately, as this author remarks, a didactic exposition of the symptomatology of this lesion is almost impossible, on account of the variations it presents according to the degree of the compression.

Diagnosis of Nerve Compression.—*Rapid or acute compression* of nerves may be confounded with *lead palsy*, which is distinguished from it by the loss of muscular contractility, by the immunity of the supinator longus, by the ordinarily bilateral nature of the disease, and by the progressive muscular atrophy which accompanies it, and which is characterized by beginning in the adductor muscles of the thumb, by the slowness of its course, by the considerable wasting of the muscles, by the irregular distribution of the atrophy, by the preservation of the cutaneous sensibility, and finally by the cramps and fibrillar contractions which are seen in the muscles beginning to be affected.

Slow compression is especially liable to be confounded with the effect of a recent traumatism, and with a cerebral or spinal lesion. I shall not revert to the characteristics which distinguish it from *recent traumatisms*, as these have been sufficiently described under the heading of symptomatology. *Cerebral lesions* are recognized by their often sudden onset, by the greater frequency and isolated loss of movement, and finally by the persistent excitability of the muscles by electric currents. Lesions of the *spinal cord* are generally bilateral, and the muscles are still irritable, if the lesion is not too extended; in the latter case, the other symptoms would leave no doubt as to diagnosis. In cases of *anæsthesia* of the skin, the procedure of Stich may be resorted to; if the skin where *anæsthesia* is present can be made the starting point of reflex action, the lesion is central, but otherwise nothing can be affirmed upon this question. Finally, Weir Mitchell has remarked that in affections of the nerve trunks the sense of touch is lost at once when it is going to be so at all, while in lesions of the nerve centres of a progressive character, there is at first a gradually increasing retardation in the transmission of tactile impressions, before their complete disappearance.

Prognosis of Nerve Compression.—The prognosis as regards the local condition is dependent upon the state of the faradic muscular contractility: it is

more unfavorable if the muscles no longer contract; no case, however, should be considered hopeless. The prognosis of slow compression depends upon its duration, and especially upon its cause, the removal of which affords the only hope of recovery.

Treatment of Nerve Compression.—The treatment of this lesion offers nothing special; it consists in the methodical application of electricity to the muscles, in order to prevent their atrophy. The cause of the nervous compression should be immediately removed. Patients who use crutches should have them made with two branches [and a hand-rest, so as to relieve the axillary nerves], and of suitable length.

CONTUSION AND CRUSHING OF NERVES.—*Contusion: Pathological Anatomy and Physiology.*—The slight habitual gravity of these lesions has rendered their study difficult in man, and accordingly the chief information that we possess upon the subject, especially as regards pathological anatomy, has been obtained from physiological experiments, the most important of which have been those of Tillaux, Weir Mitchell, and Arloing and Tripier. Let me say at once that Tripier blames the first two observers for having departed somewhat from the conditions found in clinical practice, by dealing directly with the denuded nerve trunks. Their results, however, coincide with those of Arloing and Tripier. In cases of slight contusion, the last-mentioned authors have never found any lesions of the nerve fibres; after more severe contusions there have been observed a very slight hemorrhage and a tearing of a few nerve fibres; but generally there are seen only very trivial alterations, irregularities of contour, and a moniliform appearance. If the nerves are examined at the end of several days, when the paralysis has almost disappeared, in the animals experimented upon, there is found scarcely any appreciable trace of these lesions.

Finally, after the most violent contusions, there is seen a hemorrhage which separates the nerve from its sheath, traversing the lamellæ of the perineurium, and sometimes insinuating itself into the midst of the nerve fibres; secondarily, the nerve trunks thus injured present the same alterations as follow incomplete sections, with the exception of the interruption of continuity of the nerve fibres. At a later period, the axis cylinder probably also disappears. It is in these cases of violent contusion that a consecutive tumefaction of the nerve may be observed, sufficiently marked to simulate a neuroma (Tripier).

Etiology.—Slight contusion is the most frequent traumatism of nerves. Cases of violent contusion are seldom met with, on account of the deep position of the nerve trunks and their mobility, which permits them usually to elude the vulnerating agent.

Contusions of nerves may be caused by direct force, the nerve being caught between a resisting surface and the body causing the contusion; as in luxations of the shoulder, for instance, which frequently lead to paralysis of the circumflex nerve by contusion and stretching, or in fractures, in which the contusion may be due to the vulnerating agent, or to fragments of bone, splinters, etc.

Symptoms.—Contusion of a nerve generally occasions a transient *pain*, accompanied with *formication* and *numbness*; these symptoms are usually of short duration, and probably correspond to those cases of slight contusion after which, in animals, no lesions have been found. On the other hand, it sometimes happens that with the same functional disturbances at the beginning, there supervenes, more or less tardily, muscular atrophy, preceded

or not by pains. Some authors even report cases of late, grave disturbance, without any symptoms having occurred at the time of the injury. Almost constantly, however, when the contusion is violent, it is immediately manifested by a more complex set of symptoms, pain, immediate and very acute, lasting from a few minutes to several hours, accompanied or followed by a numbness of variable duration, and, finally, succeeded by more or less complete paralysis, both of sensation and motion, the onset of which may be delayed until several weeks after the occurrence of the injury. In the latter case, according to Tripier, it will generally be found to be due to inflammation, or to nutritive disturbances, which react in turn upon the nerve centres.

Such are the signs of contusions of *mixed nerves*, which, moreover, are those most frequently affected. If the traumatism affects *nerves of general sensation*, the clinical picture differs only in the absence of muscular paralysis, but it is then particularly that anæsthesia and analgesia may be seen to exist separately. In regard to the *nerves of special sense*, they may be directly injured, and there is then present an exaggeration or destruction of their functions; a lesion of the fifth pair would also compromise the functional activity of the nerves of special sense. Finally, death may result from the contusion of certain nerves.

Course and Terminations.—The paralysis generally diminishes and disappears spontaneously, or in consequence of treatment, unless as the result of a complete crushing of the nerve, concerning which a few words will be said hereafter, or of some complication. Sensations of pricking, and sometimes tolerably acute pains, announce the return of sensibility, which usually precedes that of motion, although the contrary is not rare. The electric contractility returns pretty quickly, and always before voluntary movements. The re-establishment of the functions takes place from the proximal towards the distal extremity of the affected members; the paralysis may continue for a few days, or may be permanent, but generally complete recovery is obtained.

The most annoying and the most frequent complication of nerve contusion is neuritis, with the trophic disturbances which are its consequence, and of which the determining cause frequently remains unknown. According to Duchenne de Boulogne, it is due to a deep-seated lesion of the nerves, and is especially to be dreaded when the muscles have lost their electric contractility; the atrophy will never be marked when electric contractility is preserved.

Muscular atrophy generally begins during the first month following the injury. It manifests itself by deformities of two kinds—some due to the disappearance of the contour of the muscles, the others to the action of antagonistic muscles. This atrophy is studied in the section devoted to nutritive disturbances secondary to nerve wounds.

Crushing of Nerves.—Tripier insists that this term should be reserved for cases in which all the nerve-fibres are affected, and their power of transmitting impressions destroyed. More or less acute pain is observed at the moment of injury—pain which may be absent if the disorganization is complete from the outset. The only symptom peculiar to crushing is the total abolition of the affected nerve's power of transmitting impressions, and, in consequence, the complete disappearance of the power of motion and sensation in the territory supplied by the injured nerve. This complete motor and sensory paralysis is not always easily recognized soon after the occurrence of the accident.

The cases which may simulate this lesion are those in which traumatic

shock is present, or merely local numbness.¹ Therefore it is not important to test the sensibility at the moment of the accident; and even complete anæsthesia does not indicate crushing, unless it persists for several days. The paralysis and total anæsthesia may, on the other hand, be overlooked, on account of recurrent sensibility and substituted mobility; but it is sufficient to understand these phenomena in order to ascribe to them their due importance.

Following these injuries, the phenomena of inflammatory reaction are frequently very marked, and the process of reparation is long and difficult, especially if the crushing involves some extent of the nerve trunk. In crushing, the continuity of the nerve is not destroyed, because the neurilemma remains untorn; but there is a more or less complete rupture of the nerve fibres, the spaces thus produced being filled with blood and myeline. Beyond the seat of the crushing, the nerves sometimes insensibly resume their calibre, sometimes they appear irregularly dilated. In examining the nerve after five or six days, there can be sometimes found degeneration of nerve fibres which do not present any traces of injury, and which have only been the seat of general agitation or distension.²

Diagnosis of Contusion and Crushing of Nerves.—If the patient is seen soon after the injury, the history and traces of the contusion of the soft parts give some clue to the nature of the lesion. At a later period, and in the absence of any precise information, the paralysis from contusion of a nerve may be confounded with that due to *cerebral causes*, distinguishable by the perfect preservation of the reflexes and of electro-muscular contractility; or with *lead palsy*, which may be particularly recognized by the persistence of the action of the supinator.

The determination of the injured nerve is deduced from a knowledge of its course and distribution. In regard to the latter question, it has been already said that the lesions may seem to be more extended than they are in reality, on account of the local numbness, which is more or less pronounced at the moment of the injury. It must also be remembered that there may exist a semi-paralysis of the muscles which are innervated by the nerves in the proximity of the injured nerve; a phenomenon which was formerly attributed to concussion of these nerves (Follin).

As to the diagnosis of the degree of the lesion, this can only be made some time after the injury, and depends, as we have seen, on the more or less complete disappearance of mobility and sensibility, and above all upon the state of the electric contractility of the muscles.

Prognosis.—The prognosis of nerve contusion is not always grave, even when this has been very severe; the inflammation which supervenes may rapidly subside; nevertheless, according to Weir Mitchell, the lesions which follow contusion are more enduring than those which depend upon a different nervous lesion apparently more severe. The danger is evidently proportionate to the degree of the nervous lesion, and accordingly the state of the electro-muscular contractility determines the prognosis. The hyperæsthesia which sometimes follows faradization is a favorable symptom. On the contrary, contraction of the atrophied muscles is a sign of ill omen.

¹ But in extensive wounds by crushing, such as are met with in railroad accidents, the traumatic shock may be attributed to the crushing of the peripheral nerves, which reacts upon the nerve centres.

² Crushing a nerve by means of forceps has been sometimes practised in addition to its elongation. (Verneuil.)

Treatment.—Slight contusions do not require any treatment. If it is thought that inflammatory complications are to be feared, perfect rest of the parts, and resolvers, may be ordered. If inflammation supervenes, emollients should be prescribed; afterwards, when the lesion of the nerve and of the surrounding tissues has been cured, steam baths, frictions, massage, etc., will be indicated in order to arouse the excitability of the parts. Local faradization serves to oppose the atrophy of the muscles, and restores their voluntary contractility.

II. STRETCHING AND AVULSION OF NERVES.

The term *avulsion* or *tearing* of nerves is employed to designate solutions of continuity of these structures, occurring in their course, or at their origin, as the result of excessive extension. The term *elongation* is reserved for the extension of nerves employed for a therapeutic purpose. During the past few years this method of treatment has acquired great importance, and it will be considered in the chapter devoted to operations upon nerves.

It is useless to dwell very much upon the *accidental extension* of nerves, the history of which will be found included in that of *surgical distension* or *elongation*.

Etiology.—The stretching of nerves may be *slow* or *sudden*; in the former case it may be due to the development of a pathological tissue, in the latter to displacement of a bone by *luxation* or *fracture*, or to certain violent movements, as in forced flexion of the thigh—a position in which the sciatic nerve is extended and spread out over the neck of the femur, as I have been able to determine experimentally upon the cadaver. Campenon reported to the Clinical Society of Paris the case of a man who had a temporary paralysis of the leg, caused by remaining too long a time upon his knees, seated upon his heel, with his thigh extremely flexed. But the most frequent cause of nerve extension is found in tractions upon the limbs, notably those practised with therapeutic intent, in reducing fractures and luxations, and especially luxations of the shoulder. This accident is particularly apt to occur when the luxation is one of long standing, which Tripier explains by the fact of the formation of partial adhesions, which prevent the nerve trunks from sliding freely in the cellular tissue which surrounds them, thus confining the stretching to a limited portion of the nerve, instead of permitting it to distribute itself over the entire length. Avulsion of nerves may also be observed in these conditions, as proved by the well-known case of Flaubert, in which the tearing of the brachial plexus from its spinal origin resulted from attempts to reduce a luxation of the shoulder. It is scarcely necessary to say that avulsion of nerves is met with in cases of total tearing away of a limb. The lesion may also complicate certain contused wounds, such, for example, as those made with hook-shaped instruments.

Pathological Anatomy.—The lesions of nerve extension will be described in connection with the operation of elongation. In regard to laceration, it may be complete or incomplete; the different parts of a nerve are not in fact equally extensible; the nerve fibres are generally broken all at the same level, before the neurilemma, which resists longer and is stretched out like a glass tube heated in the flame of a lamp. In some cases, the rupture may only affect a certain number of nerve fibres, but in these cases the unbroken fibres are so stretched, that they are changed in a manner which is sometimes irremediable. The rupture of nerves may occur at the point where the force has

been applied, but more frequently it takes place elsewhere—at points too variable, according to Trombetta, for any rule to be framed on the subject; according to the experiments of Tillaux, however, the sciatic nerve almost constantly gives way at the point of its emergence from the pelvis. As regards the resisting power of each nerve, reference may be made to what will be said in connection with the operation of elongation.

Symptoms.—The symptoms which characterize extension of nerves are all reproduced by the phenomena which are observed to follow elongation. Avulsion manifests itself by a complete loss of sensation and motion, with, according to Duchenne de Boulogne, disappearance of electro-contractility. In the case of Flaubert, already cited, there was total paralysis of the upper extremity, and of the lower extremity of the same side. Incomplete lacerations may cause the phenomena of neuritis; the secondary symptoms, however, do not differ from those observed as the result of complete sections of the nerves, which will be considered hereafter.

Sudden death, according to Tripier, is to be reckoned among the possible consequences of extension and tearing of nerves. This author, in fact, explains the cases of sudden death occurring during the reduction of shoulder luxations, under chloroform, by the existence of extensive lesions of the nerve-roots and of the spinal cord, resulting from pulling on the nerve trunks.

Diagnosis.—The functional disturbances which are observed to follow injuries to nerves point distinctly to the presence of a nerve lesion. But it is often difficult to recognize at once whether the injury is a contusion, an extension, or a rupture of the nerve. Apart from the etiological considerations which may render the diagnosis very easy, rupture may be excluded if motion or sensation persist more or less completely; without a history of the case, nerve-extension cannot possibly be distinguished from contusion, except in cases of isolated paralysis of motion or sensation, in which cases it would be manifest that the lesion was not a contusion; finally, under the same circumstances, these lesions are liable to be confounded with paralysis due to a central cause. (See remarks on compression and contusion of nerves.)

Prognosis.—These nerve lesions do not appear of themselves, or in their consequences, to be more grave than other traumatisms of nerves. Regeneration seems, indeed, possible after avulsion; at least we are justified in thinking so on account of the cures obtained by Duchenne de Boulogne. (Follin.) A guarded prognosis should be given in cases of incomplete laceration, for fear that a neuritis might follow. Finally, the possibility of a sudden death should be remembered by the surgeon in his attempts at the reduction of old luxations of the shoulder.

Treatment.—The treatment does not differ from that of all nerve wounds; it consists in fixation of the part in a favorable position, the use of resolvents, of anodynes, and finally of electricity, to guard against muscular atrophy. The secondary lesions do not present any special indications for treatment, and the reader is therefore referred to what will be said upon the subject in connection with wounds of nerves.

III. WOUNDS OF NERVES.

Classification.—Wounds of nerves may be *simple*, or they may be *complicated*, either by a certain amount of contusion and crushing of the nerve-termina-

tions, or by lesions of the surrounding organs (vessels, muscles, etc.)—lesions which are almost always met with in connection with wounds of nerves which have not been produced experimentally—or, finally, by the presence of foreign bodies. According to their etiology, wounds of nerves are divided into punctured, incised, contused, and gunshot wounds; varieties which present numerous analogies with each other, and which differ, especially in their effects, according as the division of the nerve has been complete or incomplete; therefore we will not consider them separately, but will set forth first the phenomena which belong to wounds of nerves in general, and point out afterwards those which are peculiar to each variety.

Etiology.—We have seen that the different causes of nerve-wounds furnish a natural basis for their classification; the simple enumeration of these causes will indicate their mechanism, and it will be sufficient to mention cutting instruments, the lancet (in bleeding), pieces of window-glass, fragments of bottles, etc., among the most frequent causes of incised wounds; and railroad accidents, which often produce contused wounds. As regards foreign bodies, these may be fragments of the vulnerating agent—the point of a foil, a whip-lash, a shot, etc.; or they may come from the organism itself, as, for example, a splinter of bone. Ligatures around a nerve, when they do not cause its division, or when they remain in connection with the central part, may act as foreign bodies; it is, therefore, necessary to avoid, at all hazards, the inclusion of a nerve in the ligature of an artery.

Pathological Physiology and Anatomy.—Traumatism of nerves almost exclusively affect those of animal life, especially the spinal nerves, and particularly the nerves of the extremities—more often those of the upper than those of the lower extremities, the nerves of the forearm, and among these the median and ulnar, being those which seem to be most frequently involved. The lesions of the integument and neighboring parts vary with the cause. It is evident that the derangement of the parts will be less in punctured than in contused wounds, in which there is, as a rule, more or less destruction of the soft tissues, even excluding those cases of general crushing of a limb, in which the injury to the nerve forms only an insignificant part of the lesion. Finally, there are usually observed as complications of nerve-sections, lesions of the muscles, tendons, and vessels—notably at the wrist, where the division of the tendons of the flexor carpi radialis and flexor carpi ulnaris often complicates wounds of the median and ulnar nerves.

The nerve-trunks themselves present alterations of different kinds. There may be a simple separation of the nerve-fibres, in what may be considered a typical puncture—though in reality some of the fibres are always divided; or a more or less complete section of the nerve-trunk, and varying separation of its two ends, this being greater when the nerve is less adherent to the surrounding tissues, and being always more marked, unless under special circumstances, in the upper than in the lower segment. Finally, the surfaces of the section may be smooth, as in experimental neurotomies, but are more often irregular and disorganized. Immediately after the injury there is seen at the level of the nerve-wound, if the section is incomplete, an effusion of blood, which is located either between the nerve-fasciculi, or between them and the neurilemma; if the division is complete and the separation marked, there occurs an effusion of blood, varying in amount, between the extremities of the nerve—an effusion which reunites and surrounds them. If the wound is a simple one, and the patient in good condition, the two extremities of the nerve are soon united by a cicatricial tissue, through which, if the separation is not too great, its continuity is ultimately re-established. It may be said at once that

the immediate union of a nerve has never been observed; we shall see hereafter, in studying the process of repair, what led surgeons to admit such an occurrence, in spite of the constant opposition of physiologists, who had never observed it in their vivisections.

When the ends of the nerve are too far separated, or when there exists an obstacle between them which prevents their union, they swell and are separately cicatrized, the central end being the most swollen—probably, according to Föllin, on account of its greater vascularity. The distance at which the two ends of a nerve can no longer unite, varies with the age of the patient. From vivisections it is found that a gap of six or seven centimetres ($2\frac{3}{4}$ inches) is only exceptionally closed. The nerve-trunk of new formation is complete in animals at the end of from four to six months; in man the time has not yet been positively determined; the nerve-trunk always remains smaller than the original nerve. We shall see hereafter what are the phenomena of degeneration and regeneration which take place in the divided nerves, but the succession of phenomena is not always favorable, and different alterations may persist either in the peripheral end alone—as, for example, in case of absence of union and regeneration—or in the central end itself, as in the case of incomplete division. The lesions which are then met with are neuritis and sclerosis, which it is sufficient to mention here. These changes may extend far from the point originally injured, and frequently reach the nerve-centres. Finally, in some experimental cases, there has been found atrophy of certain portions of the spinal cord without appreciable lesion of the central end of the injured nerve (Avezon). The encysting and toleration of foreign bodies [within nerves], admitted by Tillaux on the authority of Otto Weber, must also be referred to. There are no cases to establish the fact of such a termination, which is possible, but must be brought about very slowly.

Beside the lesion of the nerve-tissue, there may also be found in chronic cases certain atrophic or dystrophic lesions in the territory supplied by the injured nerves, and even in that supplied by neighboring nerves. For the present I shall content myself with a mere mention of these lesions, which will be again referred to in connection with the secondary symptoms of nerve-wounds.

Symptoms.—The symptoms of nerve-wounds may be divided into the *primary symptoms*, which manifest themselves at the moment of the injury and during the following days, and the *secondary symptoms*, which supervene at a later period, and which depend upon the degeneration or inflammation of the injured nerve.

The primary symptoms are *local* or *general*. The latter, more seldom met with, are *general convulsions* which especially follow incomplete sections of nerves, and are due to the intensity of the pain and the nervous irritability of the patients, and, above all, to traumatic shock, which is said to be observed frequently in cases of contused wound of the neck (Weir Mitchell).

The primary local symptoms are *pain* and defects in *sensation* and *motion*. At times there is noticed a local stupor, which consists in inactivity, insensibility, and coldness of the limb, and which is especially seen in cases of gunshot wound. This symptom rarely occurs, except in connection with traumatic shock, in the other varieties of nerve-wounds, unless there has been considerable hemorrhage.

The pain is acute and persistent in cases of punctured and incomplete incised wounds, and is also acute, but of short duration, in cases of complete division. At other times it is lancinating and stinging; and sometimes it is absent, especially in cases of gunshot wound. If a foreign body is present, the pain persists, and is increased by the slightest touch.

The pain does not always occur at the moment of injury, but some seconds or some minutes afterwards; it may be located at some distance from the wounded nerve, and even upon the opposite side of the body (Weir Mitchell).

The immediate disturbances of sensibility and motility are generally absent in punctured and incomplete incised wounds of nerves, at least in animals, according to Arloing and Tripier, but, on the contrary, are constantly present in cases of complete division; they will be considered hereafter. Other authors have noticed after incomplete section an imperfect disappearance of motion and sensation, notably suppression of the former with preservation of the latter, or the separate loss of the muscular sense or of tactile sensibility. In complete nerve-sections, the rule is, the disappearance or diminution of sensibility and motility. Arloing and Tripier have remarked that exploration practised a short time after the injury, generally reveals paralysis and complete anæsthesia in the zone of the injured nerve, and frequently in that of the neighboring nerves; this phenomenon is due to the concussion of the nerve, and may last several days, if the traumatism has been violent. The general condition of the patient must also be considered; thus intoxication, free bleeding, or the fact of having recently submitted to surgical anæsthesia, explains in many cases the different results which have been obtained by several observers. The exact appreciation, however, of functional disturbances is far from being a simple affair, and it is therefore only when the patient has sufficiently recovered from his emotion and injury, that it is advisable to test his sensibility and power of movement.

Beside the paralysis and lessening of sensibility, there have been sometimes noted jerkings, tremblings, and tonic and clonic spasms. According to Weir Mitchell, there is observed at first an elevation of temperature, due to the paralysis of the vaso-motor nerves, and afterwards a fall, caused by a diminution in the calibre of the vessels.

I will not stop to describe the symptoms resulting from lesions of the *sensory nerves*, which are altogether of a special character, and which consist in the exaggeration or abolition of the functions of these nerves.

Between the primary and secondary symptoms may be placed the local accidents which may occur as complications of nerve-wounds. The most important of these are phlegmonous inflammation and neuritis, the latter seldom beginning before the second or third week, and often at a much later period. The acute form is extremely rare, the subacute or chronic form being that which is almost always met with. For more minute details as to the phenomena consecutive to wounds of nerves, the reader is referred to the section devoted specially to this subject.

It will be seen that the functional and trophic disturbances, consecutive to wounds of nerves, are divided into those which are peripheral and those which are due to central irritation.

I. The *peripheral disturbances* include: (1) *Sensory disturbances* (pain, causalgia, anæsthesia); (2) *Motor disturbances* (paralysis, spasms, electro-contractility); (3) *Nutritive disturbances*, among which are cutaneous lesions (glossy redness, phlyctenæ, pemphigoid eruptions, ulceration, herpes zoster, traumatic herpes); lesions of the epidermis, the hair, and the nails (see Plate XXVI.); interference with the secretion of sweat and changes of the local temperature; lesions of the cellular tissue (œdema); lesions of the joints, bones, muscles, and tendons; and (4) *Neuro-paralytic inflammation*.

II. The *disturbances from central irritation* are divided into two classes, according as there is no apparent lesion of the nerve-centres (traumatic neuralgia, neuralgia of stump, convulsive spasms, general epilepsy, tetanus, mental disorders), or as the disturbances may be attributed to a myelitis,

which is itself consecutive to an ascending neuritis; in this class are placed the *reflex paralyses*, which are known as immediate paralyses without atrophy, and as late paralyses with muscular atrophy and myelitis.

Diagnosis.—The surgeon may be called upon to make the diagnosis in a case of nerve wound, either at the moment of injury, or a certain time afterwards, when the secondary symptoms have supervened. At the time of injury it is not difficult to make a diagnosis, the history, the site of the wound, the acute pain felt by the patient, and the various disturbances of motility and sensibility being sufficiently characteristic. But the diagnosis of the kind of wound is often very difficult, and is based chiefly upon the history and upon the lesions of the soft parts, which differ, for example, in incised wounds from those met with in contused wounds; nevertheless, an acute pain which radiated towards the periphery, without either disturbance of sensation or motion, would indicate a *punctured* wound; loss of sensation and motion in the region supplied by a nerve, without very acute pain, would suggest the presence of an *incised* wound; numbness and tingling would favor the idea of a *contused* wound; increase of pain and of the general symptoms, upon pressure, would be especially met with in cases complicated by the presence of *foreign bodies*, which under such circumstances would be commonly found by exploration of the wound, and, finally, the more or less complete loss of the functions of the injured nerve would distinguish a *complete* from an *incomplete* section.

The diagnosis of the particular nerve which is injured will depend upon a knowledge of the course and functions of each nerve. But great allowance must be made, in the appreciation of the symptoms, for the variations that may arise from the degree of excitability of the patient, and especially must the surgeon distrust the results furnished by examinations made immediately after the injury, as has been already pointed out when speaking of symptomatology. In conclusion, it is especially by observing the sequence of phenomena, the quick or slow appearance of the secondary symptoms, or, on the contrary, the rapid restoration of the nervous functions, that the diagnosis of the variety of the lesion may be arrived at, taking care in considering this last order of facts to avoid attributing to the injured nerve the sensibility which it owes to the recurrent filaments, and the movements produced through the muscles innervated by neighboring trunks.

When secondary symptoms are present, it is still to be remembered that they are due to an old nerve wound, and it must be decided whether we have to deal with a *neuritis* or a *sclerosis*; finally, it will be well to know whether the lesion has reacted upon the nerve centres, in order to appreciate the nature of the intervention required and the opportunity of its application.

The secondary symptoms of nerve-wounds may be confounded with cerebral, spinal, rheumatic, or lead palsies, which may be distinguished, the first by the retention of electro-muscular contractility, and the others by the general condition of the patient and the accompanying symptoms, but, above all, by the etiology, which is in truth the only certain means of diagnosis of surgical nerve-lesions. It is also important to be on the watch for old and forgotten morbid conditions, as, for example, a coxalgia dating from infancy, which may have caused disturbances of sensibility and motility that are only noticed by the patient upon receiving an injury, and that the surgeon may be tempted to attribute to a nerve lesion.

Finally, it must be remembered, that certain affections of the digital extremities (whitlows, burns, and chilblains) may be followed by trophic and functional disturbances which may also extend in these cases to the parts supplied by neighboring nerves.

As regards the *diagnosis of the cause of the secondary symptoms*, neuritis cannot be distinguished from sclerosis and atrophy of the nerve trunks, unless the secondary symptoms have supervened very quickly, or unless the neuritis has determined, previous to the paralysis, symptoms of motor excitation. Finally, the absence of exact limitation of the muscular paralysis, at a period remote from the infliction of the injury, should lead the surgeon to suspect a lesion of the nerve centres.

Prognosis.—Benign as far as the wound is concerned, traumatic lesions of nerves are grave through their consequences. The prognosis is the more serious in cases of incomplete division, and in those of contused wounds and wounds complicated by the presence of foreign bodies, which are more liable to be followed by the sequelæ referred to than those in which the nerve-section is complete. Moreover, in regard to recent wounds, the prognosis varies with the general condition of the patient, with the lesions of the surrounding parts, and, in general, with all the circumstances which may favor or retard the re-establishment of the nerve functions. A guarded prognosis should always be given, therefore, in cases of neuritis or persistent neuralgia, on account of the imminence of trophic disturbances.

In chronic cases, the prognosis depends upon the state of the electro-contractility of the muscles; but the absence of this should not lead the surgeon to despair of re-establishing their function, for it may be restored under the use of electrization. In cases of intense neuritis, there may be observed tonic contractions, which indicate the irreparable loss of the properties of the muscle, which, moreover, then undergoes atrophy with great rapidity.

Treatment.—The immediate treatment of wounds of nerves presents several indications; pain is to be obviated, as is inflammation, and separation of the ends of the nerve in cases of complete division. All authorities agree in advising rest of the limb, obtained, if necessary, by means of an immovable apparatus, in such a position that the injured nerve shall not be pulled upon; resolvents and antiphlogistics if the inflammatory complications are threatening; opiates, subcutaneous injections of muriate of morphia, or even inhalations of ether or chloroform, to allay the pain which immediately follows the injury, or preferably chloral if there is a tendency to muscular spasm; finally, at a later period, sulphate of quinia, if the neuralgia assumes an intermittent form. If the painful symptoms persist in spite of this medical treatment, which does not often occur, except in cases of punctured wound and of incomplete division of the nerve, surgical intervention becomes necessary, and instead of the cauterizations employed by the older surgeons, enlargement of the wound by incision is now preferred, that is to say, the conversion of an incomplete into a complete nerve-section. But the failure of medical treatment to relieve the early pain is not frequent enough to justify preventive incisions in all cases of incomplete division, as has been advised by some German authors. In order to obtain immobilization in a favorable position, Tripier recommends, in all cases of nerve wound, that the limb should be placed in a moderately tight silicate of potassium bandage, in which a fenestra can be cut, if the patient complain of pain, and which, if there is the slightest sign of constriction, can be transformed into a gutter [posterior splint] by splitting it in its entire length. But this method of treatment, though well adapted to many cases, may at times be dangerous on account of the obstacle which it offers to the examination of the parts, the local or general numbness perhaps preventing the patient from being conscious of a constriction which is the more dangerous that it is exerted upon

a limb of which the vascular and nervous equilibrium has been suddenly modified.

In cases of complete division of the nerve, besides the position to be given to the limb, the uniting of the ends of the nerve by means of a suture must be considered. This operation is to be described in a special section, and it will be sufficient to say here, that most surgeons of the present day admit that it is of itself a harmless operation, and one which should always be resorted to when it is possible. In cases of great contusion of the extremities of the nerves, some surgeons still advise the suture after resection of the disorganized portions of the nerve-trunks; Tripier, however, rejects this procedure as absolutely useless and dangerous.

Finally, in cases where a foreign body is imbedded in the substance of the nerve, or is in contact with its divided ends, the first indication is evidently to remove it as quickly as possible.

In regard to after treatment, it is advised, in cases of prolonged *anæsthesia*, to employ electrization of the skin without moisture, by means of a strong current applied with a metallic brush, or frictions with warm oil of turpentine, which are at times very painful. In case of *neuralgic pain*, after having ascertained that it is not caused by the presence of a foreign body, antiphlogistics, resolvents, and if there is neuritis, sedatives are indicated, and particularly water-dressing and blisters for causalgia; the treatment by opiates is appropriate if there is *sclerosis*, and, as a last resort, neurotomy, which, however, should only be employed after medical treatment has failed. Tripier prefers to operate by open incision, and simply divides the nerve; relapses in his opinion depending less upon early cicatrization of the nerve, than upon the persistence of other ways of transmission. But most surgeons advise resection of one or two centimetres [half an inch or an inch] of the nerve. Malgaigne, moreover, advised, in order to avoid any possibility of reunion, that both ends of the nerve should be folded back in loops, and that the lower end should be cauterized, or that a flap of tissue should be interposed between the cut extremities; even these precautions, however, do not always insure against relapses.

The treatment of the *motor disturbances* consists especially in electrization by induced currents, in order to prevent muscular atrophy and loss of contractility; electrical needles also may be employed. Methodical electrization may, as we have seen, even re-establish muscular contractility some time after it has disappeared. According to some authors, it is proper to wait until the nerve is repaired before applying interrupted or continued, and especially descending, currents.

In cases of muscular contraction, resort is had to prothetic apparatus, to forced straightening, to tenotomy, and particularly to baths, douches, and kneadings (massage).

When both ends of the nerve are separately cicatrized, it is a question whether they should be sought for and united by suture, or whether the peripheral end of the divided nerve might not be united to a neighboring nerve which has not been injured. It is to experimental physiology and clinical observation that we must look for a solution of this question, which at present cannot be answered.

FOREIGN BODIES IN NERVE-WOUNDS.—To what has already been said concerning the presence of foreign bodies in wounds of nerves, it may be added that every foreign body gives rise to local irritation, and sometimes to unbearable pain and to severe accidents. The oft-quoted case of Dupuytren's may be cited, in which the patient died from tetanus, the end of a whip-lash being found at the autopsy imbedded in the ulnar nerve. Descot has pub-

lished a case of tetanus which supervened after an amputation of the thigh, and was attributed to the presence of a ligature knot in the sciatic nerve.

It has not been proved, as previously mentioned, that foreign bodies in nerves can become encysted or be tolerated.

In all these cases the consecutive symptoms are dependent upon the existence of neuritis, and at times the changes are so far advanced, that a return to the normal condition does not take place, even after the removal of the foreign body.

This, indeed, is the first indication to be fulfilled. In a case in which the pain persisted in spite of the removal of a grain of lead imbedded in the median, M. Le Fort obtained a cure by the operation of elongation or nerve-stretching.

LIGATION OF NERVES.—The study of foreign bodies in nerve-wounds leads to the consideration of the ligation of these organs. The importance of this accident, which may occur in various operations, renders it proper to devote a short space to its consideration. Its study may be pursued both from the side of experimental research and from that of clinical observation.

Experimental Facts.—Researches upon this point have been made for a long time by several authors, among whom may be mentioned Thierry, Valsalva, Descot, and Arloing and Tripier. The latter have determined that small nerve branches are almost severed by the thread; in the case of larger branches, the constriction never immediately interrupts the continuity of the nerve, on account of the resistance of the neurilemma, but the transmission of impressions does not take place. If a nerve has been tied at the same time as an artery possessing thick walls, by immediately removing the ligature, the integrity of a certain number of nerve fibres may be counted upon; this is important in regard to the motion of the parts. If the ligature is rapidly removed, the nerve subsequently presents a swollen appearance on a level with the point of compression.

The anatomical changes which follow ligation have been well described by Descot. There occurs a plastic infiltration above, below, and around the ligature; the two ends of the nerve are maintained in exact apposition by the thickening of the surrounding cellular tissue; they are never separated from each other.

Arloing and Tripier in their experiments have determined that animals feel pain at the moment of constriction, and that the functions of the nerve are interrupted; they have never observed any secondary nerve symptoms.

Clinical Facts.—Surgeons at the beginning of this century, while endeavoring to avoid including an artery and a nerve in the same ligature, did not believe that any danger could result from such an accident. Larrey and Swan opposed this opinion, and the former, in a case of tetanus, suspecting that one of the branches of the crural nerve was included in the ligature, cut the latter with the effect of producing a remission in the symptoms. We have already cited a case of Descot's, in which, the patient dying of tetanus, a ligature-knot was found in the sciatic nerve. In a case of Richerand's, the ulnar artery and nerve were included in the same ligature:—

“A sharp pain was felt in the ring and little fingers at the moment at which I tightened the knot,” says Richerand; “the palmar surface of the little finger and the ulnar side of the ring finger lost their sensibility; this was gradually re-established, and they had recovered it at the end of fifteen days.”

To recapitulate: Ligation of nerves, according to experiments upon animals, has not caused secondary nervous accidents; but can it be said from this that it must be the same in man? Unquestionably not. In some cases

eminent surgeons have believed that they had found the cause of tetanus in the presence of a ligature around a nerve. These cases must be seriously considered, and care should be taken, in ligating arteries, that the nerves are not included. If the occurrence of such an accident is recognized, the ligature should be cut without hesitation, contrary to the practice which would seem to be indicated by a remark of Richerand, quoted by Descot, to the effect that, if in a ligation the nerve is taken up at the same time as the artery, it is not necessary to recommence the manœuvre. The practice of arterial ligation *en masse* may also, therefore, be not without danger. On the removal of parts with the *écraseur* or ligature, there are generally encountered only small nerve ramifications, which are not protected with a thick neurilemma. These operations are painful, but do not appear to be accompanied secondarily by grave nervous symptoms.

CAUTERIZATION OF NERVES.—But little need be said of the effects of cauterization upon nerves. Formerly employed in the treatment of certain diseases of the nerves, it is at the present day abandoned. It is to be remembered that the nerve-trunks and branches, by the thickness of their sheaths and the mode of distribution of their vessels, resist, better than the other soft tissues, the different processes and agents of disorganization—burns and cauterizations. This is a fact which should not be forgotten in cases of deep burn. Ranke admits that heat may cause rigidity of nerves, as it does muscular rigidity. Some authors also admit that the physical and chemical constitution of nerves may be modified by cold. Crecchio has seen the medullary substance of the nerve-fibres become solid, a phenomenon accompanied by suppression of every nervous manifestation.

Cauterization is seldom followed by accidents. There is, however, a case recorded by Dr. Frère, in which an application of caustic potassa involved the musculo-cutaneous nerve; there ensued a flexion of the forearm upon the arm, trismus, and tetanic contraction of the muscles of the neck and trunk, and the patient died on the fifth day.

IV. PHENOMENA CONSECUTIVE TO INJURIES OF NERVES.

PROCESS OF REPAIR AFTER WOUNDS OF NERVES.—The knowledge of the phenomena which result in the regeneration of nerves after traumatism which have destroyed their continuity, is entirely due to experimental physiology. It is by the aid of experiments made upon animals that it has been possible to follow, day by day, the delicate modifications which are produced in the intimate structure of the divided nerve-trunks, and which in time bring about, with an anatomical restoration *ad integrum*, the re-establishment of the suppressed functions.

The discovery of Waller, in showing that every nerve separated from its trophic centre undergoes a complete degeneration of its peripheral end, marks the first step in this line of research. Waller saw, at the same time, that the degenerated segment was not for ever destroyed, but that after a certain time there took place a true work of regeneration. He considered this regeneration to be the result of a kind of budding of the nerve-fibre remaining in connection with the axis cylinder, the parts of the nerve separated from the centre not taking any part in the process. The experiments of Remak, Schiff, Vulpian, Neumann, and Ranvier, have completed the teachings of Waller.

In order to thoroughly understand the manner in which the repair of a divided nerve is effected, it is well to rapidly review the *modifications under-*

gone by the peripheral end, as they have been made known to us by the researches of the above-named physiologists.

During the first twenty-four hours which follow the section of a nerve—the sciatic of a rabbit, for example—the nucleus of each nerve-segment is seen to increase considerably in size; the protoplasm swells and enlarges; in places it is seen to encroach upon the myelin, and to produce in it an outline of segmentation. The segmentation of the myelin is completed on the following day, and the sheath of Schwann becomes filled with large masses, which are colored black by osmic acid. These masses continue to divide during the third day, and at the same time the axis-cylinder, until now intact, is cut in two at the position of the nucleus, while above and below it takes a moniliform appearance. From the fourth to the sixth day destruction is completed, the sheath of Schwann is filled with fine, fatty granules, and the axis-cylinder disappears, no trace of it remaining. The nucleus of the nerve-segment undergoes division, and heaps of nuclei are seen to be formed.

At this period the fat granules, which fill the sheath of nerve-fibre, seem to diffuse themselves outside of it. The cells of the endoneurium are filled with them, and also the endothelia of the neighboring bloodvessels. Ranvier thinks that this fatty overloading of the cellular elements is connected with the absorption and disappearance of the myelin of the nerve-fibre. From the seventh to the twentieth day, in fact, the axis-cylinder and myelin having disappeared, and the nuclei of new formation diminishing more and more, the sheath of Schwann becomes empty and folds upon itself, its walls joining together. About the thirtieth day after the section, there are only found empty sheaths of Schwann, strewed with flat nuclei surrounded by a desiccated protoplasm (Ranvier).

Such are the modifications undergone by the peripheral end. Analogous phenomena are produced in the central end, but they do not extend very high; the disintegration of the myelin, according to Ranvier, does not generally pass beyond the first annular constriction above the section. Moreover—a distinction of importance—the axis-cylinder does not undergo any alteration; it remains intact, distinctly fibrillar, a little enlarged up to the level of the section. It is in this central end that the process of repair begins. How is it produced?

We have said that in the peripheral segment the axis-cylinder disappears as well as the myelin. It cannot, then, be longer admitted, as formerly believed by Vulpian and Philippeaux, that the regeneration is due to the simple reproduction of the myelin sheath—an opinion which has, indeed, been abandoned by both these authors themselves. Others thought that the axis-cylinder was simply re-formed in each of the old empty sheaths of Schwann, and was surrounded with an envelope of myelin. The idea advanced by Waller of the budding of the nerve-fibres of the central end is the opinion which Ranvier has been led by his researches to recognize as true. The following is, according to the learned Professor of the College of France, the process of repair:—

Each end of the cut nerve swells so as to form a kind of bud—the *central bud* and the *peripheral bud*; these two swellings are united by a tissue analogous to that of granulations—the *cicatricial segment*.

In the central segment, as early as the eighteenth day after the traumatism, the budding of the nerve-fibres begins to take place. It is at the level of the first annular constriction seated above the section that the fibres of new formation appear. Ranvier has carefully described the different forms taken by the new nerve-fibres. Sometimes there is seen a myelinic fibre formed of short, interannular segments, arising from the constriction, and penetrating into the sheath of Schwann, in order to reach the cicatrix.

Sometimes it is an amyelinic axis-cylinder which appears, soon dividing into a Y, and each of its branches being surrounded with myelin, and giving origin to two nerve-fibres. At other times three myelinic fibres are appended to the convexity of the same constriction. Finally, the same nerve-fibre, by a series of dichotomous divisions, may produce twenty, thirty, or forty new fibres.

These fibres penetrate into the cicatricial segment, where they appear, colored by osmic acid, as a skein of tangled threads. The nerve-fibres, when separated, form a considerable number of small fasciculi, or are mingled in varying number with fibres of Remak and myelinic fibres. The latter become more numerous as the time of section becomes more distant; but it cannot be admitted, according to Ranvier, that there is a transformation of Remak's fibres into myelinic fibres.

Finally, when the peripheral segment is examined by dissection, there are seen among the sheaths of Schwann, completely emptied and folded upon themselves, other sheaths containing in their interior one, two, or even ten or twelve myelinic fibres of new formation. These new fibres are formed of very short interannular segments, each provided with a nucleus; they then constitute perfect nerve-fibres, but excessively small. All these new fibres are not contained in the old sheaths of Schwann; some penetrate into their interstices, rolling themselves around them, or spreading out freely, sometimes in rectilinear fasciculi with more or less frequent Y divisions, and sometimes in a confused and inextricable network.

Thus, according to both Ranvier and Waller, the regeneration of nerves is due to a budding of the nerve-fibres remaining in connection with the centres, the fibres of new formation traversing the cicatrix in order to reach the peripheral end, where they are developed either in the interior of the old sheaths of Schwann or in their interstices.

The *duration of this process of repair* is very variable. In the rabbit, the regeneration begins as early as the twentieth day. But it is only about the beginning of the third month that the effects are sufficiently well marked to be successfully studied; the repair is complete about the beginning of the sixth month.

The above are the phenomena produced in animals as the result of a simple section. Is it the same with nerve-wounds in man? This is very probable, if the wound is clean-cut, if the nerve-ends are but little separated, and if neither attrition nor very violent inflammation results from the traumatism. Neuritis, however, is not as rare an occurrence as it has been deemed. It is evident that if the interfascicular tissue of the nerve become inflamed, the process of regeneration will be inevitably arrested. Now there are cases in which the proliferation of the connective-tissue elements in the interstices of the nerve-fibres becomes very abundant, and there may result a true cirrhosis of the nerve. It is very important that this epineuritis, described by Erb, should be recognized; if it only affects the peripheral end, it is even then very grave, since it entirely or partly prevents the re-establishment of the functions of the nerve; if it extends to the central end, and ascends towards the centres, it may have consequences to which we shall have occasion to refer hereafter.

FUNCTIONAL AND TROPHIC DISTURBANCES CONSECUTIVE TO INJURIES OF NERVES.—Among the disturbances which follow traumatism of nerves, there are two great classes to be distinguished. In the first, we place the symptoms which are the direct consequence of the nerve injury, and which result from the separation of the nerve from its central connections: these are *peripheral disturbances*, properly speaking; in the other we place the re-

mote phenomena, the *phenomena of irradiation*, which are dependent upon the reflex effect of the injury upon the nerve-centres. The symptoms of the first class are evidently dependent upon the alterations undergone by the peripheral end, degeneration of nerve-fibres, and, in certain cases, more or less marked interstitial inflammation. The pathogeny of the disturbances of the second class is more obscure; they are attributed to the ill-understood modifications which occur in the central end, and which may extend to a greater or less height, and even to the nerve-centres themselves.

I. PERIPHERAL DISTURBANCES.—To this group belong the disturbances of sensibility, motility, and nutrition, which are observed in the territory of the injured nerve; we will study them in succession.

(1) *Sensory Disturbances*.—The first symptom experienced in consequence of an injury of a nerve is an acute *pain*, the characters of which vary; sometimes there are shooting pains, radiating along the whole course of the injured nerve; at other times there are smarting sensations, numbness, or tingling. In gunshot wounds the pain may be absent, perhaps overlooked in the special conditions of excitement in which the wounded are placed. In ninety-one cases recorded by Weir Mitchell, more than one-third of the patients had felt nothing at the moment of injury.

Be this as it may, this primary pain should be distinguished from the phenomena of hyperæsthesia which supervene at the end of a certain time, and which Weir Mitchell has admirably described under the name of *causalgia*. The sensation of *burning pain* which constitutes causalgia, is of an extreme intensity; patients compare it to the pain produced by a sinapism, a blister, or a red-hot iron, applied upon the denuded derm. This pain occupies as its seat of predilection the palmar surface of the hand, and the dorsal surface of the foot; it is generally accompanied by a glossy condition and a redness of the skin, which belong to the class of nutritive disturbances. The affected parts are exquisitely sensitive; the least touch, or the slightest grazing, awakens the sensation of burning and provokes a paroxysm of atrocious suffering. Weir Mitchell attributes the causalgia to an alteration of the extremities of the sensory fibres, due to disturbances of the circulation and nutrition consecutive to the irritation of the injured nerve. But it must not be forgotten that causalgia is observed in neuritis, properly so called—in the brachial neuritis, for example, of cervical Pott's disease. In the causalgia, then, which follows traumatism of nerves, especially if this causalgia be accompanied with lancinating pains, a true inflammation of the injured nerve-trunk may be thought of, rather than simple circulatory disturbances of irritative origin.

The hyperæsthesia may be slight, when there are observed, at the same time, tingling, numbness, and formication, along the course of the injured nerve, especially in cases of contusion or compression. If temporary, these disturbances have no great importance; if they persist, or if they become exaggerated, and complicated with darting pains, the development of an interstitial neuritis must again be dreaded.

Even in cases where this exaltation of painful sensibility exists, there is at the same time a notable diminution of the tactile sense. *Anæsthesia* is, in fact, the most constant consequence of nerve-sections. But the distribution as well as the degree of this anæsthesia is very variable. It would appear that, after the section of a nerve, the sensibility should be completely abolished in all the region supplied by that nerve; but this is far from being always the case.

In the first place, sensibility may not be destroyed in all its manifestations:

thus cases have been noted, in which sensibility to pain was abolished, while tactile sensibility persisted. Tripier refuses to credit the authenticity of these cases; but sensibility to temperature may be totally suppressed, while tactile sensibility and sensitiveness to pain continue more or less perfect.

Thermo-anæsthesia is the most constant and best marked phenomenon which results from lesions of nerves. Patients do not feel the burning produced by a match, but perceive the prick made by a pin. As to tactile sensibility, if it is examined by means of Weber's compass, in cases of complete section of the nerve, it is, according to Tripier, always impaired; never has he seen, in such a case, the patients able to feel both points of the compass, whatever their separation, though they feel punctures more or less clearly.

Let us next inquire what is the distribution of this anæsthesia. During the first moments which follow the traumatism, it is difficult to appreciate with exactness the state of the sensibility, the condition of the patient rendering it inadmissible to trust with entire confidence to his replies. It is, however, probable that the complete section of a nerve has always as an immediate consequence the loss of sensibility in the territory supplied by the nerve. At a later period, one of two conditions may be presented: either the anæsthesia persists, thus limited—and these are the most common cases; or else sensibility reappears after a variable time, in the zone innervated by the divided trunk. The first examples cited of this rapid re-establishment of the sensibility, after ten, fifteen, or thirty days (cases of Bécлар and of Paget) were explained by a secondary reunion of the parts of the divided nerve, more prompt than was ordinary. The case of Laugier, in which the sensibility reappeared some hours after suture of the two ends of the median nerve, might lead to a belief in the possibility of immediate reunion. But the case published a few years afterwards by Professor Richet does not admit of this interpretation. Twenty-four hours after section of the median nerve at the lower part of the forearm, before the use of any suture, sensibility existed in the entire hand, with the exception of the palmar surface of the last phalanges of the forefinger. This anomaly could only be explained by the existence of anastomotic or recurrent filaments.

The investigations of Arloing and Tripier have, in the opinion of Professor Vulpian, definitively established this point in science. In operating upon dogs and cats, these physiologists have ascertained that it is impossible, in the upper extremity, to mark out the portions of skin which, from a functional point of view, would be under the control of the ulnar, the median, or the radial nerve. The areas of distribution of these nerves encroach more or less upon each other. As long as a nerve-trunk remains, connecting the extremities of the limb with the nerve-centres, sensibility persists, more or less weakened. Arloing and Tripier have demonstrated that this fact is explicable by the existence of true recurrent fibres, which are mutually sent to each other by the different nerves; the recurrence of these fibres occurs principally in the neighborhood of the skin, or in its thickness, where they form a part, more or less, of the peripheral network, and then reascend along the different trunks to spend themselves and disappear at a certain height; these fibres remain intact at their peripheral end, while the direct fibres undergo the Wallerian degeneration.

These experiments, as the authors recognize, are not directly applicable to man, the distribution of the nerves not being the same as in the cat or in the dog; by analogy, however, they permit a satisfactory explanation of cases similar to that of Professor Richet.

(2) *Motor Disturbances.*—*Muscular paralysis* is the natural consequence of section of a nerve. May it too be wanting, like anæsthesia? May there be a

substitution of motility (*motilité supplée*, of Létievant)? Some cases of this kind have been reported, but they must be received with great hesitation. Those cases only in which examination of the electro-contractility has been carefully practised can be considered as convincing. If, indeed, the observer is contented with making the injured person execute voluntary movements, it is quite possible that these will appear only slightly embarrassed. As Tripier remarks, if a single nerve has been injured, error may readily arise from observing the action of those muscles, the nerves of which have not been cut, and which, in the normal state, take more or less part in the execution of the same movements as do those, the nerve-supply of which has been interrupted.

Muscular hyperæsthesia, transient clonic or tonic spasms, and a kind of fibrillar contraction (Weir Mitchell), have been described in the muscles innervated by the injured nerve. "In certain cases," says the American author, "the nerve wound, in place of causing primary loss of mobility, occasions either sudden muscular contraction, followed by instant loss of power, or, in very rare instances, long-continued spasm. A soldier, wounded in the brachial plexus, at Antietam, was obliged to ask a comrade to unclasp his rigid fingers from their hold upon the musket." But these phenomena are rare, and it is not necessary to dwell upon them further.

The most interesting point is the study of the *electro-contractility*. Until within the last few years, most physiologists asserted that, after the section of nerves, the electro-contractility persisted almost indefinitely in the muscles. The researches of Barwinkel, Erb, and Biernssen, have made known new facts which it is important to notice. These researches have related especially to the influence of galvanic currents, and the conclusions to which they have led are sufficiently exact for physicians to hope to obtain great advantages, both from a diagnostic point of view and from that of the prognosis of nerve lesions.

When a nerve has been cut, in an animal, there is produced as in man a motor paralysis, and in time an atrophy of the muscles. In these conditions, the examination should be made with the aid of continued and interrupted currents; it should be directed to the nerve itself and to the muscles.

Let us first see what takes place in the examination of the *nerve*. In the case of a section, or of a complete crushing of the nerve, it is found that faradization and galvanization give identical results; the electric reaction rapidly diminishes; before the end of the first week it is entirely absent; the excitability of the nerve is abolished for both kinds of currents. If recovery is going to occur, and if regeneration of the nerve is taking place, the excitability gradually disappears; at first feeble, it rapidly increases and returns to the normal condition.

When the *muscle* is examined, the course of affairs is different. During the first fifteen days, the *faradization curve* becomes gradually depressed. After the third week, the muscle is no longer excitable, at least through the skin. Toward the sixth week, in favorable cases, the excitability reappears, and gradually increases until it reaches the normal reaction. But the *galvanization curve* follows an entirely different course. During the first fifteen days, it follows the faradization curve, but from the third week, when the interrupted currents have no longer any effect, the galvanic reaction is exaggerated, the curve is raised, soon exceeding the normal, and reaches its maximum when the other is at its minimum. This is what the Germans call the *reaction of degeneration*. At the moment that repair begins to take place, the phenomena follow an inverse order; at the same time that the faradic curve is raised, the galvanic curve is lowered, and both gradually return to the normal level.

If, instead of a favorable case, we suppose a case in which the regeneration of the nerve does not occur, there is no ascent of the faradic curve, and the galvanic curve, after being elevated, falls again to the normal, and then continues to sink until the reaction becomes null; the excitability of the muscle and of the nerve is then abolished for ever.

Do the same phenomena occur in man, as in animals which are made the subjects of experiment? Precise observations are not sufficiently numerous to permit this fact to be definitively affirmed. It is not to be forgotten that Professor Vulpian has called in question the certainty of the reaction of degeneration. A minute study of these electric phenomena in the traumatisms of nerves, is then necessary before we can apply in all certainty to man the results observed in animals.

(3) *Nutritive Disturbances*.—I do not purpose giving here the history of the general question of trophic disturbances of nervous origin. Limiting myself to that which concerns lesions of the nerves, I will say that Professor Chareot published, in 1859, the first observations of herpes zoster, consecutive to a traumatic nerve-lesion. A few years afterwards, the writings of Paget, in England, and especially the remarkable work of Drs. Mitchell, Morehouse, and Keen, in America, made known most of the nutritive alterations which may be determined by a nerve wound. The names of Brown-Séquard, Samuel, Vulpian, Mougeot, and Couyba, are also connected with this question, and it will suffice to have mentioned them before beginning the enumeration of the various disturbances which it is proposed to study.

I shall first describe the *cutaneous lesions*, as they are also the first to attract attention. These lesions are very variable; we may see them ranging from a simple, smooth redness of the skin, to deep alterations of the derm, without being able to explain by a distinct cause the diversity of these manifestations. All that is known, is that the effects vary according as the section of the nerve is complete or incomplete. This is a fact upon which the American surgeons have with reason insisted. The cutaneous lesions, as well as the other trophic disturbances, are especially observed in cases of incomplete section.

A *glossy redness* of the skin, with or without bullous elevations of the epiderm, is one of the most frequent phenomena. It has been variously named "glossy skin," "eozematous eruption," and "erythema." The skin of the fingers, according to Paget, is smooth and shining in the most marked cases; the affected fingers are ordinarily tapering, glossy, hairless, devoid of wrinkles, and shining, with a more or less deep-red color, uniform or in patches, as in chilblains. This glazed redness occupies the fingers, the palmar surface of the hand, and the dorsal surface of the foot. It is ordinarily accompanied by violent neuralgic pains, and by the very painful burning sensation which has already been mentioned under the name of *causalgia*.

The redness may exist alone, but more often it is complicated, as in a burn of the first degree, with the formation of larger or smaller *phlyctenæ*. At times these are small vesicles, disseminated or in groups; sometimes large bullæ, which raise the epiderm over the limits of the erythematous redness. These bullæ, filled with a lemon-colored serum, may rupture and leave the derm exposed, leading to the occurrence of persistent ulcerations, and to an increase of the smarting pains.

The *pemphigoid eruptions* still more frequently give rise to the formation of obstinate ulcers; they are rapidly developed, generally upon the fingers. The fluid which they contain is serous, sero-sanguinolent, or sero-purulent. When the epiderm ruptures, there remains a more or less deep *ulceration*, which is ordinarily very long in cicatrizing.



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Herpes zoster forms a separate class in the eruptions of this kind. While the glossy skin appears to be peculiar to traumatisms of nerves, herpes zoster appears here with the characters which are habitual to it, either in spinal affections or in cases of spontaneous neuritis. There are isolated groups of vesicles, which appear upon red patches separated by intervals of healthy skin, and which are distributed along the course of the injured nerve. It is useless to dwell upon the evolution of these vesicles, which terminate by desiccation, as in non-traumatic herpes zoster, but which may also, although rarely, be complicated with ulceration or limited gangrene. Professor Verneuil has distinguished three varieties of *traumatic herpes*: (1) herpes which appears along the course of the nerve, below the wound; (2) herpes of proximity, which occurs in the neighborhood of the wounded nerve; (3) remote herpes, which occurs far from the seat of the injury, as the result of a kind of reflex irritation.

I have said that the bullous and pemphigoid eruptions frequently terminate in obstinate ulcerations. These ulcerations may occur even without a preceding eruption. To this category it has been proposed to refer the affection known as "perforating ulcer of the foot." While it is true that frequently the occurrence of a perforating ulcer is singularly favored by the previous existence of trophic disturbances of nervous origin, this affection is not met with unless a local compression intervenes, as has been demonstrated in the theses of two of my pupils, Soulages¹ and Butruille.² It is not the same with the ulcerations which may appear on the surface of the toes in consequence of sections of the sciatic nerve or of its branches; in these cases the intervention of compression is not necessary, just as in the ulcerations of the extremities of the fingers which result from section of the median nerve.

To these lesions which affect the derm, are joined various alterations of the epiderm, or of its appendages, the hair and the nails. Its thickening, its yellowish or brownish discoloration, and its desquamation in small dry scales, which are slow to separate, are the modifications of the *epiderm* pointed out by Weir Mitchell and by Couyba. The *hairs* come out in the regions where the glossy skin occurs, though at times they are found increased in number and lengthened in cases of painful irritation. As to the lesions of the *nails*, it is again to Weir Mitchell that we are indebted for their best description. The nails may become thick and club-shaped, or, on the other hand, may undergo atrophy, becoming dry, scaly, and brittle. At other times they are curved like turtle-shells, blackened, and, as it were, elevated by the hypertrophy of the subjacent tissues; the matrix is separated from the nail and becomes ulcerated. Sometimes the nails present an antero-posterior incurvation; sometimes they are rolled up transversely, and then become very painful; finally they may be completely shed, and then grow again unevenly.

[By the great courtesy of Dr. Weir Mitchell, the editor is permitted to have reproduced here the accompanying illustration (Plate XXVI.) of the trophic changes in the skin and nails following nerve injuries. Dr. Mitchell's original paper will be found in the Transactions of the College of Physicians of Philadelphia, 3d series, vol. ii., p. 115.]

In connection with these nutritive disturbances of the skin, must be mentioned the modifications of secretion and temperature which have in some cases been observed. According to Weir Mitchell, *the secretion of sweat* may be abolished after complete section of a nerve; it is increased in incomplete sections with irritation.³ In other cases the sweat has a very marked acid smell, especially in cases of causalgia.

¹ Thèse, Paris, 1875.

² Thèse, Paris, 1878.

³ Often, in trophic disturbances of the foot, of nervous origin, I have observed the sudden profuse sweatings which appear at the moment that the foot is examined.

The *state of the temperature* in the paralyzed parts has not been much studied, except by the American surgeon. When the peripheral end is irritated, there will be a slight elevation of temperature. After complete section, at the end of a certain time, there will always be lowering of temperature. In a case of contusion of the nerves of the arm, with immediate paralysis of the muscles of the forearm and of the hand, M. Terrillon observed, twenty-four hours after the accident, a difference of over six degrees (11° Fahr.) in the temperature of the two limbs; the thermometer placed in the paralyzed hand marked only 23.9° (75° Fahr.), while in the hand of the opposite side it marked 30.5° (86.9° Fahr.). The scarcity of recorded cases does not permit further dwelling upon this part of the question.

The trophic disturbances which affect the more deeply seated tissues are, with the exception of the muscular changes, very much more rare.

The *lesions of the cellular tissue* are limited to a certain degree of *œdema* more or less marked. This *œdema* may appear and disappear again several times at intervals. In the end, it is possible that the subcutaneous tissue may remain thickened and indurated. Weir Mitchell has seen, following a gunshot-wound of the arm, an elephantiasis-like swelling of a portion of the hand. As to suppuration, the case reported by Couyba is the only one which would indicate the possibility of this termination.

The lesions of the bones and articulations are not much more common; at least the published cases are few in number. The principal characters of the *arthropathies*, or joint-diseases consequent upon secondary nerve-injuries, are: a painful swelling, which may attack one or all the joints of the limb; a slight redness around the articulation; extreme sensibility of the affected joints; and, finally, persistent rigidity, with a semi-ankylosis which resists all treatment. "When the acute stage has disappeared," says Mitchell, "the tissues around the articulation are indurated, and there results a partial ankylosis." These joint-inflammations appear a certain but variable time after the traumatism, and are accompanied by the other disturbances which we have noted as affecting the skin, and sometimes by a more or less extended inflammatory *œdema*. The joints in the part supplied by the injured nerve are alone involved. Microscopic examination of the articulations thus affected has rarely been made. In a case published in the *thèse d'agrégation* of Blum, the histological study of the parts, in a man who died seven years after a complete section of the median nerve, showed that the cartilages of the diseased articulations were softened and thinned, and presented a marked cellular proliferation; the bones were rarefied and likewise thinned, the compact layer also being diminished in thickness.

The few examples known of *osseous lesions resulting from nerve-wounds* have been collected by W. Ogle. Cases of *necrosis* following accidental or operative nerve-wounds have been recorded, but the most frequent lesion appears to be *atrophy* of the bone. I have already mentioned Blum's case. Lobstein observed a remarkable instance of atrophy of the femur, in a man who, when a child, had received a serious wound of the thigh, involving the sciatic and crural nerves. In another case of Ogle's, in consequence of a wound of the median nerve, the ulna and radius were found united at their lower part by an osseous deposit; there was an extremely marked atrophy of the bones of the hand, which had preserved their shape, but had become very light and transparent.

The different trophic disturbances which have been enumerated are not a necessary result of traumatic nerve-lesions; on the contrary, the *muscles* to which the cut nerve is distributed inevitably undergo, after a certain time, the alterations which will now be described. This is easily explained with the view that is now held as to the relations of muscular fibre with the nerv-

ous system. According to Ranvier, according to Professor Chareot, the motor cell of the anterior cornua of the spinal cord, the axis-cylinder which is thence derived (and which extends, surrounded by myelin, as far as the terminal plate), and finally the muscular fibre, form a continuous whole intimately united, to which the name of neuro-muscular system may be given; the nerve-cell is, through the terminal plate, directly imbedded, as it were, in the muscle-cell. Every degeneration of the axis-cylinder must then inevitably react upon the muscle-cell.

We have seen that as early as the seventh day after section of a nerve the destruction of the axis-cylinder is complete; the nerve no longer exists. It is at this moment that the *alterations of the muscle* begin to appear. The first changes are in the muscular nuclei, which proliferate and form chaplets; the intimate substance of the muscle remains normal, preserving its striated aspect; there is not, as was formerly believed, a granulo-fatty degeneration. But the muscular fasciculus undergoes a diminution in size, a very rapid emaciation. At the same time there occurs a connective-tissue proliferation of the peri-mysium, whence an exaggerated formation of interstitial tissue, which incloses, and, as it were, chokes the muscular fibres. During the second month, when regeneration of the nerve is taking place, these alterations disappear, and the muscle returns to the normal state. But if regeneration does not occur, the lesions progress indefinitely and lead to irreparable atrophy. At the end of ten or twelve months, the muscular substance is represented only by small and extremely slender fasciculi, which preserve to the last their striation. *Interstitial cirrhosis* gains the ascendancy, there is a rudiment of muscle enveloped by a mass of fibroid connective tissue, sometimes loaded with fat vesicles. This deposit of fat may be exaggerated, giving rise to the condition which the Germans call *luxuriant lipomatosis*, and it can be understood that this excessive development of fat may give to the really atrophied muscle an appearance of normal size.

Muscular atrophy is then the inevitable consequence of the section of a nerve—reparable, if the nerve is regenerated, irreparable if there is permanent destruction of the nerve trunk. Does it as necessarily result from a simple section as from an irritation of the nerve? It is known that Brown-Séquard had established a capital distinction between the effects of irritation and those of simple suppression of nerve action. Chareot, who had applied this distinction to the interpretation of the different trophic disturbances, and had accepted without restriction the theory of Brown-Séquard, has recurred to this point in the second edition of his book, and with some reservations. These are rendered necessary by the results furnished by examination of muscles after nerve lesions. The experiments of Vulpian, of Neumann, and of Eiehhorst, prove that muscular atrophy is constant whenever the continuity of the axis-cylinder is interrupted. The effects of the cessation of nerve-action, then, do not differ here from those of irritation. Is it the same for articular and cutaneous trophic disturbances? I shall not attempt to decide this delicate point. What it behooves us to remember, is that, clinically, the consequences of simple nerve sections are certainly not the same as those of wounds with irritation. Every one agrees, in regard to this matter, that the observation of Weir Mitchell is absolutely true, namely, that the trophic disturbances from nerve-wounds are especially developed in consequence of incomplete sections, of contusions, of punctures—of causes, in a word, which determine an irritation of the nerve—and that a simple division of the nerve-trunk does not, as a rule, entail similar consequences. This leads us to speak of the influence of nerve-sections upon the phenomena described under the name of neuro-paralytic inflammation. But first I will terminate what has reference to the lesions of the muscular system, by saying that I have seen a

gunshot wound of the radial nerve followed by a swelling of the back of the hand, due to a trophic disturbance of the extensor tendons and their sheaths.¹

(4) *Neuro-paralytic Inflammation*.—The types of this kind of inflammation are furnished by the broncho-pneumonia consecutive to section of the pneumogastries, and by the alterations of the eye which follow section of the trifacial. Experiments made upon animals have demonstrated that section of the tenth pair determines a passive congestion of the lungs, œdema, emphysema, nodules of hepatization, and an intense inflammation of the bronchial mucous membrane. Again, when the trifacial is cut within the cranium, the conjunctiva becomes inflamed and secretes a puriform mucus; the iris becomes red, and is covered with false membranes; the cornea, after the first twenty-four hours, begins to look cloudy, and at the end of five or six days becomes of a milky whiteness from plastic infiltration and the formation of crystals of carbonate of lime; the pituitary mucous membrane becomes spongy and bleeding; and ulcerations occur upon the lining membrane of the lips. These phenomena, first described by Magendie in 1824, have been verified by all physiologists. But their interpretation has given rise to animated discussions, and unfortunately, as we shall see, a satisfactory explanation yet remains to be given.

Three principal hypotheses have been suggested: (1) Is there a modification of vaso-motor action? (2) Does the nerve section suppress, or does it irritate, certain fibres with special functions, called nutritive or trophic? Or (3), finally, does it only play a secondary part by favoring the action of external traumatisms?

Every one knows the celebrated experiment of Pourfour du Petit and of Claude Bernard. Section of the sympathetic nerve in the neck produces a vaso-motor paralysis, with redness, elevation of temperature, and swelling of the paralyzed parts. These are phenomena which are very analogous to those of inflammation; but nevertheless it cannot be said that there is an inflammatory lesion. Every one acknowledges at the present day that vaso-motor paralysis determines a simple fluxion, and is not capable of producing a true phlegmasia. The parts attacked are in imminent danger of inflammation, so to speak; a phlegmasic predisposition is created; but in order that inflammation should be developed, the intervention of an accessory cause, mechanical or chemical, is required. As regards the lung, it is not even necessary that this vaso-motor paralysis, admitted by Schiff and Genzmer, should intervene. Professor Vulpian has demonstrated that neither section nor electrization of the vagi modifies in any way the color of the respiratory mucous membrane. According to M. Vulpian, the vaso-motor nerves of the lung are contained in the filaments of the sympathetic nerve, and not in the trunk of the pneumogastric.

Ought we to admit a direct trophic influence? Traube and Steiner deny such an influence. According to them, the pulmonary lesions are due to the accompanying paralysis of the muscles of the larynx; the entrance of particles of food into the bronchi irritate the anæsthetized and defenceless mucous membrane, and this traumatic irritation is the real cause of the inflammation. It must be said, however, that Traube's hypothesis does not explain all, since Genzmer and Michaelson have obtained the same results, the same broncho-pneumonic lesions, by cutting the vagi below the recurrent, so as to avoid laryngeal paralysis, and the consequent entrance of particles of food. These authors admit that the lesions are due to vaso-motor paralysis; but, as we

¹ Gazette Médicale, 1873, p. 458.

have said, the vaso-motor nerves of the lung do not seem, according to the experiments of Vulpian, to be contained in the pneumogastrics. It is therefore impossible to decide this question.

Do the experiments made upon the trifacial lead to a clearer interpretation of the observed changes? Here again the paralytic congestion due to section of the vaso-motor nerves contained in the trifacial does not explain the inflammatory lesions, since section of the sympathetic itself determines a much more marked congestion without nutritive disturbances. This congestion, then, cannot be considered but as a predisposing cause.

The hypothesis of a direct trophic disturbance has more partisans. But do there exist in the trifacial nerve any special trophic fibres, or, on the contrary, is the nutritive influence common to all the fibres of the nerve trunk? On the other hand, are the lesions due to a destruction or to an irritation of these fibres?

Meissner and Merkel admitted that the trophic fibres of the trifacial were contained in the internal part of the nerve-trunk. There would be no disturbances of the eye if this internal part were avoided, and if only the external part were cut. Inflammatory disturbances would then be produced by the suppression of certain fibres of the trifacial. Samuel, on the contrary, thinks that these phenomena are caused by irritation of the cut nerve. By thrusting two needles into the Gasserian ganglion of a rabbit, and passing through these needles an induced current, for some time, he caused the development of the same phlegmasic lesions of the eye. This experiment seems unsatisfactory to M. Vulpian, on account of the situation of the Gasserian ganglion, and the difficulty of being certain that the ganglion alone is involved. The trophic disturbances observed in man as a result of neuralgia or neuritis of the trifacial, would seem, however, favorable to Samuel's hypothesis. But the complexity of clinical observations scarcely permits, according to Vulpian, of their being invoked in support of any particular hypothesis in a discussion of this kind.

There remains the hypothesis of external injury. Snellen and Buttner have shown that if, after section of the trifacial, the eye is protected, either by means of the ear, which remains sensitive through the action of the cervical nerves, or by means of a thick piece of leather, there is no alteration of the cornea at the end of six, eight, or even ten days. Eberth, relying upon these facts, explains the ocular lesions and the keratitis by the action of micrococci in the air which lodge and multiply upon the cornea, which is anæsthetic, and deprived of the power of resistance by the suppression of its nerve filaments.

It is thus seen that no more light has been thrown upon this side of the question than upon the pulmonary alterations consecutive to a section of the vagi. "It seems certain to me," says Prof. Vulpian, "that these disturbances of nutrition are due neither to an irritation of the cut nerve-fibres nor to a paralysis of the vaso-motor fibres contained in the nerve; but after eliminating these suppositions, we find ourselves in the presence of hypotheses upon the value of which we have no sufficient information." If the experiments of Snellen are to be trusted, the contact of foreign bodies is the determining cause of the alterations, the vaso-motor paralysis creating conditions favorable to the development of inflammation.

This also seems to be the true explanation of the cases of inflammation with ulceration which are observed as the result of sections of the peripheral nerves, of the sciatic, for example. In this case, the part played in the production of the ulcerations observed in animals by pressure of the foot upon the ground, or of the bones upon the soft parts, does not appear questionable.

And it is thus, no doubt, that must be explained the frequency with which perforating ulcers are developed in consequence of injuries of the sciatic nerve in man.

Still, it is far from being the case that the external injury, in connection with the vaso-motor paralysis, is sufficient to account for all the inflammatory disturbances consecutive to nerve lesions. Without speaking of the eruptions and glossy skin, the joint inflammations do not seem to be explicable in this way.¹ There is here very probably a direct action exercised by the nervous system. But it must be confessed that the nature of this action is unknown. Is there a diminution of the trophic influence of the nerve centres, as admitted by Vulpian? Is there a perversion in the way of exaggeration of this nutritive influence, as maintained by Brown-Séquard? The question remains unsettled.

II. DISTURBANCES FROM CENTRAL IRRITATION.—Thus far we have studied the morbid disturbances which are produced in the peripheral domain of the injured or divided nerve. But it is not only in the periphery that the influence of the nerve lesion is felt. Although more rare, the *alterations of the central end* and the consequences which they may have upon the cerebro-spinal axis itself are none the less indisputable. Here again physiology furnishes an important contribution to the question, and the results obtained by experiment may serve as a foundation for the description of clinical facts.

It is to Tiesler, Feinberg, Klemm, Niedieck, and Hayem, that the most conclusive experiments are due. These authors have shown that an injury, and especially an irritation, of the peripheral part of a nerve, determines in it changes which in a great number of cases are propagated even to the spinal cord. The contradictory experiments of Roessingh, of Rosenbach, and of Vulpian, show that this propagation is far from being constant; but they do not impair the value of the positive results established by the first-named investigators.

The *ascending neuritis* which follows the irritation of a nerve trunk is a *disseminated neuritis* (Klemm); it invades the tissue of the nerve in an irregular manner, and is particularly observable at the points where the arterial vessels penetrate the sheaths of the nerve trunks. This neuritis is above all *interstitial*. But Hayem, in his experiments, has also noted a *parenchymatous neuritis*; he has seen the axis-cylinders swollen, moniliform, and in a state of granular degeneration, with proliferation of the cells of the interannular segment. "The path of transmission of the irritation from the nerve to the spinal cord," he says, "is twofold: it is effected by the interstitial tissue, and also by the axis-cylinders, which are found swollen and moniliform in the central end of the nerve."

The consequences of this *irritation of the spinal cord* have been either lesions of the membranes—*pachymeningitis* and *meningitis*—or lesions of the medullary substance itself. Meningitis is nearly constant; myelitis is more rare; it occurs like neuritis in disseminated foci, and may ascend very high, even to the medulla oblongata. With the microscope are found all the lesions of myelitis, softening of the cord, disorganization of the gray substance, destruction of the large cells of the anterior cornua, swelling and disintegration of the axis-cylinders, and multiplication of the elements of the neuroglia.

These experimental facts, upon which I do not intend to enlarge, and which it suffices to have mentioned, permit us to understand and to explain certain symptoms, uncommon indeed, but which occasionally follow injuries

¹ The pressure of the cartilages one against the other might, however, be given as an explanation.

of nerves, and which have evidently for their cause, irritation of the central end of the injured trunk.

These disturbances from central irritation may affect both sensibility and motility. The principal sensory disturbance is what is called *traumatic neuralgia*. This neuralgia, which is also observed after amputations, occurs especially in cases of *puncture* or of *gunshot wound*, or when a *foreign body* remains imbedded in the nerve. The graphic description of these phenomena given by Professor Trélat, in a case of *neuralgia of the stump*, may serve as a type for other cases. "Touch," he says, "lightly, with the end of the finger; brush the skin of the stump; and immediately the drama bursts forth in all its violence; the patient raises above the bed, with a sudden, automatic movement, the lower limb, which is immediately seized with a jerking, convulsive and involuntary trembling; his countenance, at the same time, expresses excruciating pain; it becomes pale and distorted; drops of sweat form upon his forehead; and with both hands he strives to compress his thigh, to hold his limb steady, and to overcome the trembling and the darting pain. It is no use; the paroxysm persists one or two minutes, and then all becomes calm until a new touch comes to reawaken the pain." The patient compares the pain which tortures him to that of a recent burn; it seems to him that a thousand red-hot needles are passing through his limb. Shooting pains radiate towards the periphery, and, at the same time, ascend towards the root of the limb. The pain may extend even to other nervous branches, more or less distant, and may affect the nerves of the limb of the opposite side. M. Ollivier has seen, following a contusion of the fifth, right, intercostal nerve, radiating pains in all the branches of the brachial plexus of the same side. Numerous examples of these *radiating neuralgias* may be found in Swan's treatise. Weir Mitchell admits in these cases an inflammation propagated from the injured nerve to the other branches by means of anastomoses. Professor Vulpian thinks, on the contrary, that if occasionally these neuralgias may be referred to a peripheral neuritis, it is probable that they often have, at least in part, another mechanism, and that they depend upon a modification of the gray substance at the level of the medullary centre of the injured nerve.

These traumatic neuralgias are ordinarily coincident with the phenomena described under the name of *causalgia*, and if *causalgia* is often limited to the territory of the injured nerve, it may also extend to that of the neighboring branches; there is then observed that condition of excessive hyperæsthesia which Weir Mitchell has named *sensory tetanus*. According to the hypothesis of Professor Vulpian, the irritation in these cases would be localized in the sensory, medullary centre of the nerve. But more frequently it affects also the motor centre, and, at the same time, with the neuralgia, there are observed *traumatic spasms*. These two phenomena were united in M. Trélat's patient whose history has just been cited. These spasmodic movements, especially frequent after amputations, constitute the *chorea* or *epilepsy* of stumps, and, like the pain, the spasmodic contraction may extend to distant parts. In several of Weir Mitchell's cases, the convulsive, motor excitation was seen to extend from the muscles of an arm stump to those of the neck, trunk, face, and larynx.

It is readily understood that if the irritation becomes generalized, there follows a true *epileptic attack*. The experiments of Brown-Séquard upon the epilepsy of guinea-pigs, following sections of the sciatic nerve, are well known. Cases of the same kind have been observed in man, as the result of contusions, gunshot wounds, and other grave traumatisms of the sciatic nerve. Billroth, Schaffer, Magnan, Samuel, and Wilks, have seen attacks of complete epilepsy thus produced, the initial aura having its origin from

the injured nerve. Swan, Hamilton, and Féron have described analogous facts in cases of injury of the fingers. Larrey relates that in consequence of a prick of the internal cutaneous nerve at the bend of the elbow, in a soldier, paroxysms of epilepsy supervened. The patient felt an acute pain at the level of the cicatrix, followed by a distressing shudder, which passed up the course of the nerve, on the inner side of the arm, towards the head, when convulsions immediately ensued. Wilks and Weir Mitchell have published several similar cases.

Traumatic neuralgia, convulsive spasms or local epilepsy, and general epilepsy—such are the consequences of central irritation consecutive to nerve injury. *Tetanus* need only be mentioned. The irritation may extend higher than the spinal cord. The observations of Weir Mitchell show that temporary *mental derangement* may be a sudden consequence of nerve injury. A volunteer, he says, received a gunshot wound in the brachial plexus; he immediately became like a madman, crying murder, and accusing his neighbors of having assassinated him. An officer, wounded in the arm, had the median nerve cut; he began to speak incoherently of subjects entirely foreign to the occasion and to the place in which he was. He was very weak, but had lost little blood; he had not the least recollection of his wound; he had forgotten all that had passed during the hour which followed his injury.

The various phenomena which have just been described are centripetal effects of injury of the nerves, without any true lesion, or at least any that is recognizable, of the nerve centres. Can there be an inflammatory lesion of the spinal cord, as in the experiments regarding ascending neuritis, made upon animals? A certain number of observations seem to establish the possibility of this result, apart from other facts the anatomical explanation of which is yet to be found. This is what now remains for us to study under the name of reflex paralysis.

REFLEX PARALYSIS.—This form of paralysis, described by Whytt and Prochaska under the name of sympathetic paralysis, was first observed and studied in the domain of medical pathology. The observations of Stanley made known the palsies of renal origin; those of Graves the palsies of intestinal origin. Romberg added to them the palsies from uterine lesions. The question found no place in surgical pathology until the appearance of the work of Mitchell, Morehouse, and Keen. Brown-Séquard had pointed out the existence of palsies occurring at a distance under the influence of traumatisms. But it is to the American surgeons that belongs the merit of having, by exact observations, placed beyond a doubt the reality of these palsies. Since then, new observations have still further extended the field of these phenomena, and for clinical purposes it is convenient to distinguish two classes of cases, according as the spinal medullary disturbances appear immediately after the traumatism, or are progressively developed after a longer or shorter time.

According to Mitchell, reflex traumatic paralysis is a paralysis which shows itself in wounded persons, in a region distant from the wound, when the first shock of the injury has passed. He reports seven cases. In the first, a wound of the neck was followed by paralysis of both upper extremities. In Cases III. and VI., wounds of the sciatic and crural nerves led to paralysis of an arm. In Case IV., a soldier received a ball in the right testicle; there was paralysis of the right tibialis anticus and peroneus longus. In Case II., a soldier was wounded in the right thigh; he half fell, unconscious, and paralyzed in all four limbs; movement rapidly returned in the left arm, but the recovery of the three other extremities was much more

delayed. Brown-Séquard has seen an analogous case. "I was consulted," he says, "by an American officer, who, in consequence of a gunshot wound of the cervical and brachial plexuses of the right side, became paralyzed, to a slight degree, in all four extremities, but especially in the right arm and left leg." In all of these cases, in spite of the primary gravity of the phenomena, amelioration rapidly followed, and recovery gradually became complete.

Cases of this kind are rare. To Weir Mitchell's cases may be added those of Larrey. This surgeon reports, in his *Mémoires de Chirurgie Militaire*, that during the campaign in Syria, very slight wounds of the shoulder were followed almost constantly by complete or incomplete paralysis of the corresponding limb; "which never occurs in Europe," he says, "at least if the principal nerves are not cut or disorganized." He explains these palsies by lesions of some superficial branches of the cervical pairs, and attributes also a certain influence "to the asthenic and stupefying qualities of the climate of Syria;" while Weir Mitchell, connecting these palsies with the phenomena of cerebral excitement, consecutive to traumatism, of which we have just spoken, explains these cases by a kind of local determination or nervous commotion. In place of an impression upon the cardio-motor centre, there is observed only a counterstroke upon the emotional centres, upon the mechanism of ideation, upon a sensory ganglion, upon a limited group of motor cells. Why the brain should be affected in one case, the heart in another, the motor cells in a third, it is not possible to know.

The immediate appearance of paralytic symptoms in consequence of the traumatism, and their usually rapid cure, differentiate the cases of this first group from others which we may place in a second category, and in which the spinal disturbances are more tardy, being slowly developed, and having no tendency to recovery. After a wound which has more or less directly involved a nerve-branch, there appear, usually after a considerable interval of time, symptoms either of subacute myelitis, of muscular atrophy, or of locomotor ataxia.

Locomotor ataxia, it may be said at once, is rare. A certain number of cases of ataxic tabes which seem to have been developed in consequence of peripheral traumatisms, have been published, but in no case has there been a localized injury of a nerve; the lesions have been such as have involved some extent of the integument or of the limb, such as an amputation of the leg (Vulpian), chilblains (Duplay, Nicaise), and contusions. The spinal phenomena usually noted as resulting from nerve injuries are symptoms of subacute myelitis, with muscular atrophy.

One of the first cases of this kind was published by Charcot in 1856. A vigorous man had a diffused phlegmon of the left forearm, which required five incisions. One of these incisions, made over the course of a branch of the radial nerve, injured, no doubt, this nerve-twig. Soon after, the patient felt the strength of the left arm diminishing, and was seized with sharp pains, with formication—recurring in paroxysms and starting from the cicatrix which corresponded to the radial branch—with nearly complete anæsthesia, with paralysis and atrophy of the muscles, and with a bullous eruption upon the dorsal surface of the hand and fingers. During more than a year, the left side alone was affected. Afterwards, the patient experienced a sense of feebleness and numbness of the hand and forearm of the right side. Muscular atrophy gradually ensued, as well as anæsthesia. When M. Charcot saw the patient two years subsequently, the anæsthesia seemed to be extending towards the upper part of the limb.

This case may serve as a type; the course followed by the symptoms in this case is that observed in all that have been published. Pains appear first in

the region of the injured nerve—pains which are generally violent, paroxysmal, and accompanied with formication, tingling, and sensations of smarting and burning. These pains may be accompanied with various trophic or vaso-motor disturbances, such as reddish or purplish coloration of the skin, lowering (Vulpian) or elevation of temperature (Hayem), local hyperidrosis, ulcerated panaris, bullous eruptions, etc. At the same time the limb is weakened, and the muscles are atrophied.

These phenomena may be confined to the injured limb, as in the cases of Bourke, Schwahn, Vulpian, and Hayem. In other instances they extend, as in the case of Charcot, to the opposite limb. Leyden, Vulpian, Terrier, and Le Dentu, have reported cases of this kind. But in these cases there were traumatisms very much more grave and more extended than in that of M. Charcot; large and deep burns in Vulpian's and Terrier's cases, and a penetrating wound of the knee in that of Leyden.

The extension of the symptoms may be even more considerable, as is proved by the already classical case of Barlow, and by the cases of Poncet and Heurtaux. Barlow relates that a laborer, 25 years old, gave himself a contused wound of the hand, followed by sharp inflammation, and requiring ten weeks to heal. Eventually, weakness of the hand supervened, and then of the arm. At a still later period there was complete paralysis of both motion and sensation of the entire limb. Analogous symptoms occurred in the feet, and, finally, the lower extremities became absolutely powerless and insensible. Treatment with corrosive sublimate caused some amelioration, but the patient had a fall, his condition became aggravated, his arm and his legs were again paralyzed, and he finally died. At the autopsy, the spinal cord was found reduced to a pulp in the lower cervical and dorsal regions. "It was the irritation of the peripheral nerves," says Eisenmann, in speaking of this case, "that without doubt determined, by reflex action, a stasis and softening of the spinal cord." Heurtaux's case was very analogous. Here it was a wound by a piece of bottle glass, with complete section of the left sciatic nerve, which was the origin of the symptoms. Two years after, there was complete paralysis of the left lower extremity, with muscular atrophy, and, on the right side, marked feebleness of motility and sensibility. The same functional disturbances were present in both upper extremities; the patient could move them, but without any energy; sensibility was blunted. There was incontinence of urine and of feces. At the autopsy, both ends of the sciatic nerve were found, separated by an interval of eight centimetres (3 inches +). The spinal cord was softened throughout its entire length, the softening affecting particularly the posterior columns; it was white softening without a trace of vascularization. In Poncet's case, a gunshot wound of the right brachial plexus determined a paralysis of the corresponding arm. Three years afterwards, in 1873, the left arm was already beginning to become weak. In 1875, the lesions were symmetrical in the two upper extremities. There was paralysis with atrophy of the biceps, of the brachialis anticus, of all the posterior muscles of the forearm, and of all the interossei; the thenar eminence was slightly flattened. Sensibility was abolished upon the dorsal surface of the forearm. There was, besides, atrophy of the pectoral, trapezius, deltoid, and upper part of the latissimus dorsi. The serratus magnus was beginning to be involved; a decrease in size of the glutei was recognized, and a general weakness of the lower limbs.

In all these cases it is seen that *muscular atrophy* is the constant and predominant symptom. The paralysis consecutive to injuries of nerves is eminently an *atrophic paralysis*. This peculiarity is important, for one of the most remarkable consequences of experimental neuritis propagated to the spinal cord—a consequence described by all investigators—is the rapid

atrophy observed in animals operated upon. This atrophy is in correspondence with the lesions described by M. Hayem in rabbits; the myelitis consecutive to ascending neuritis is a gray myelitis, with degenerative alterations of the cells of the anterior cornua. Now, although we do not know the spinal lesions with which the symptoms that we have been describing correspond, since hitherto no microscopic examination of the spinal cord has ever been made in these conditions, it may, without rashness, be supposed that the alterations are very analogous to those which have been observed in animals; and it is upon the constancy of the phenomena of muscular atrophy that this supposition can rest with the most probability.

If then the cause of the immediate palsies of our first group remains yet quite unknown, it may be admitted that the more tardy, atrophic palsies which are consecutive to nerve-injuries, are connected with the extension of inflammation from the injured nerve to the spinal cord, the subacute myelitis which is its consequence being sometimes localized, sometimes extending to a greater or less distance, and affecting especially the large motor cells of the anterior cornua.

INFLAMMATORY LESIONS OF NERVES.

The inflammatory lesions of nerves include *congestion* and *neuritis*.

CONGESTION OF NERVES.—Congestion of nerves is frequent, since it is generally met with in all nerves which are involved in a focus of inflammation, and often extends beyond that focus (Cornil and Ranvier). It may be caused by traumatisms, or by excesses of heat or cold. It was experimental cooling of the nerves, that permitted Weir Mitchell and Waller to study congestion of these structures. Congestion of nerves may also follow exposure to moist cold, or to the impression of a current of air (rheumatic neuralgia).

In congestion, the nerves are slightly swollen; upon their surface are seen red lines which indicate hyperæmia of the perifascicular vessels; the intra-fascicular vessels are also dilated, and there occur a serous exudation in the perifascicular connective-tissue, and often miliary hemorrhages.

The symptoms of congestion are not very definite. There are observed sharp pains, throbbing (as in cases of chilblain and whitlow), formication, numbness, hyperæsthesia, and occasionally muscular weakness. There is pain upon pressure at the level of the congested point.

We have seen that certain neuralgias, termed rheumatic, have been attributed to congestion of the nerves. We also admit the existence of paralysis *a frigore* (Capozzi), due to the reflex action of cold upon the motor nerve-fibres, a paralysis which is constantly recovered from. Certain contractions have been attributed to hyperæmia and to œdema of nerves; Jobert, Wunderlich, and Brown-Séquard, have considered congestion of nerves as the cause of tetanus.

NEURITIS.—The history of neuritis is yet far from being complete. It seems that there are united under this name anatomical lesions of different causes and nature: inflammation, properly so called, with its exudates; and progressive, ascending or descending, sclerosis or cirrhosis of the nerve. Inflammation manifests itself differently, according to the tissues and organs; nerves offer to it a remarkable resistance, especially in regard to acute inflammation. Experimental investigators have ascertained the difficulty of causing acute neuritis, and the impossibility of producing ascending neuritis,

in animals. Thus the nerves retain their properties in the midst of foci of suppuration, while the perifascicular tissue is the seat of hyperæmia, serous exudation, and even diffuse suppuration (Cornil and Ranvier).

The resistance of nerves is connected with the structure of the lamellar sheath, and with the anastomoses of the vessels in the perifascicular and intrafascicular connective-tissue. This special circulation of the nerves indicates to the surgeon that he should not hasten to resect the ends of nerves, in contused wounds for example; and it also explains the possibility of denuding a large extent of a nerve (in the operation of elongation, for instance) without exposing it to mortification.*

Nevertheless, neuritis is still sufficiently frequent, especially in its subacute or chronic form.

Etiology of Neuritis.—Etiologically considered, neuritis includes three principal varieties:—

(1) *Traumatic neuritis.* This is observed more frequently, or is more intense, after compression, contusion, puncture, and incomplete section, than after clean-cut, complete division.

(2) *Spontaneous or primary neuritis.* This is rare; it is observed after the action of moist cold, and in subjects generally predisposed—rheumatic, arthritic, etc. It may be followed by certain palsies and neuralgias; herpes zoster belongs to this variety.

(3) *Secondary neuritis.* This is very frequent and may be subdivided into neuritis by contiguity, and the neuritis of general diseases.

Neuritis by contiguity is developed by propagation of inflammation from organs situated in the neighborhood of the nerve: neuritis of the intercostal nerves in pleurisy (Beau); neuritis of the nerves of the extremities resulting from a focus of inflammation, an arthritis, an osteitis, or other organic lesion; neuritis in Pott's disease; neuritis after alveolo-dental periostitis; neuritis following inflammation of tendons and tenotomy (Erb); neuritis in perinephritic phlegmon, psoriasis, etc.

Neuritis of General Diseases.—The acute infectious diseases may be followed by circumscribed neuritis: typhoid fever (Nothnagel); typhus fever (Bernhardt). Charcot and Vulpian described, in 1863, the alterations of the nerves in diphtheria; according to Buhl, the neuritis may, in this affection, reach the roots of the spinal nerves, and even the cord itself. Certain forms of poisoning may cause neuritis; poisoning by carbonic oxide (Leudet); alcoholism (Magnan); perhaps lead-poisoning (Charcot, Westphal).

Rheumatism and gout may be accompanied by neuritis; a fact which surgeons should well understand, for by appropriate medical treatment they may hope to cause the disappearance of persistent neuralgias, which otherwise they would be tempted to treat by operation. Syphilis occasions neuritis. In anæsthetic leprosy, there is, according to Virchow, a perineuritis which leads to destruction of the nerve fibres.

There remains now to be considered that peculiar, irritative process of the nervous tissues—a process of a progressively encroaching character—which leads to hyperplasia of the connective tissue and degeneration of the nerve fibres. In the case of the nerves, this process is considered as a form of neuritis; it is not, however, a true inflammation, but there is no special word to designate it, and its intimate nature has not yet been thoroughly determined.

This *encroaching neuritis* presents itself in the nerves in two forms: descending neuritis and ascending neuritis.

Descending neuritis, studied by Charcot, Bouchard, Cornil, and Vulpian, occurs in cases of descending sclerosis of the spinal cord, and after lesions of certain parts of the encephalon. Vulpian thus describes it: "It is known

that there is in these cases a true interstitial neuritis, which does not necessarily occasion atrophy and destruction of the nerve fibres, but which causes an increase in the size of the nerve, and is frequently accompanied by spontaneous pains along the course of the nerve-trunk, and by a state of very acute sensibility of this trunk to pressure. This lesion of nerves is observed most readily in the nerves of the extremities."

It is known that optic neuritis may be developed in consequence of lesion of the encephalon and of its membranes (Bouchut, Galezowski).

The existence of *ascending neuritis* was established by Lepelletier and Graves; it arises from the peripheral nerves, or even from the organs in which they terminate, when attacked with inflammation. This neuritis may reach the spinal cord and the nerves thence proceeding, and produce reflex paralysis.¹ It has been suggested by some authors that traumatic tetanus may be due to an ascending neuritis.

Pathological Anatomy.—Several varieties of neuritis may be recognized: if the inflammation remains limited to the neurilemma, it constitutes *perineuritis*; if it attacks the connective tissue which separates the nerve fibres, it is *interstitial neuritis*; finally, inflammation of the nerve elements themselves constitutes *parenchymatous neuritis* (Charcot, Pierret), with a moniliform appearance of the fibres, proliferation of the cells of each interannular segment, and disappearance of the axis cylinder. Neuritis is also distinguished as acute and chronic.

In *acute neuritis* there are observed redness and swelling of the nerve; there is hyperemia of the perifascicular and intrafascicular vessels, and there is formed, in the perifascicular connective tissue, a serous or sero-fibrinous exudation. Miliary hemorrhages are also observed. At a later period, if the inflammation is intense, the nerve is softened, and the nerve fibres are immersed in the midst of a red, spongy tissue, and entirely reduced to a semi-fluid pulp.

Suppurative inflammation is rare; we have seen that the lamellar sheath offers a barrier to the pus; but in wounds of nerves, the lamellar sheath being destroyed, the suppuration can reach the intrafascicular connective-tissue (Cornil and Ranvier). Generally, after acute neuritis, the elements are regenerated, and resume their functions. The inflammation may, however, pass into the chronic state, while giving rise to a connective-tissue neoplasia.

In *chronic neuritis*, which often occurs as a primary affection, there is particularly observed a tendency to the occurrence of connective-tissue neoplasia, to induration, to sclerosis. The nerve is thickened; it presents sometimes knotty enlargements, or small tumors (fibromata or myxomata), due to a circumscribed perineuritis and often confounded with neuromata (Poincaré); it is grayish or purplish, and adheres to the neighboring tissues. Frequently the cellular new formation occupies, at the same time, the perifascicular tissue and the lamellar sheath (*proliferating, interstitial neuritis*); this leads to compression of the nerve fasciculi, and to their degeneration and atrophy.

The disease continuing, the nerve is transformed into a fibrous cord, hard, pigmented, and formed of connective-tissue elements. There are found at the same time the trophic lesions which accompany neuritis. This may extend towards the spinal cord.

Symptoms of Neuritis.—It is difficult to give a general description of symptoms applicable to all cases of neuritis, as much on account of the functional

¹ Vide supra, p. 210.

diversity of the nerves as of symptoms sufficiently characteristic of nerve-inflammation.

With Nothnagel and Labadie Lagrave, we will now study neuritis in the sensory nerves, in the motor nerves, and in the mixed nerves.

(1) *Neuritis of Sensory Nerves*.—Spontaneous pain is the principal symptom; it is sharp, lancinating, or dull, in acute neuritis; it follows the course of the nerve, and extends even into the peripheral ramifications; sometimes it takes a centripetal course; it is often continuous and without paroxysms—which would serve to distinguish it from the pains of neuralgia, if occasionally neuritis itself did not cause painful paroxysms; pain also cannot be considered as pathognomonic of neuritis in the subacute or chronic forms (Labadie Lagrave¹). Pressure increases the pain, even when it is not applied to the inflamed point. According to Baerwinkel, the pain thus provoked has a centripetal direction; this would be characteristic of neuritis, but it is far from being always so. We should believe rather in the presence of a neuritis, if the pressure determined pain over a long extent of the course of the nerve.

Nothnagel has made an important remark, namely, that in a circumscribed neuritis there are neuralgic paroxysms along the entire course of the nerve, with periods of apparently complete remission, but during which a continuous pain persists at the level of the inflamed point.

Muscular hyperæsthesia has been given by Weir Mitchell as a sign of neuritis, even in the absence of cutaneous hyperæsthesia. At a later period, the loss of tactile sensibility is observed; this anæsthesia is due to the destruction of the nerve fibres below the diseased point, but the spontaneous pains persist, for the irritation which exists above the diseased point continues to be transmitted to the brain. There is then a painful anæsthesia. Sometimes the anæsthesia shows itself early, in acute neuritis (Nothnagel), and over limited points of the territory of the nerve. These patches of circumscribed anæsthesia have been observed in herpes zoster by Charcot, Rendu, and Damaschino. Hybord has observed anæsthesia in ophthalmic zona, and Rendu has studied it in anæsthetic leprosy.

(2) *Neuritis of Motor Nerves*.—The history of neuritis of the motor nerves is little known; its only characteristic symptom is paralysis, which, however, is not constant when the inflammation is slight, or when there is only a perineuritis. It is generally preceded by tremblings, muscular shocks, convulsions, and contractions; but these phenomena may exist without there being any signs of nerve inflammation.

What is the pathogenesis of these contractions? Do they result from direct, centrifugal irritation of affected motor filaments, or are they of a reflex nature? Nothnagel, while recognizing the frequency of contractions in neuritis, does not venture to decide upon their symptomatic value, nor upon their mode of origin.

When degeneration of the nerve supervenes, paralysis occurs; it is quite rapidly developed, and is characterized by the abolition of voluntary and reflex movements, and by the loss of electric contractility.

Motor disturbances may be the consequence of an interstitial, or of a parenchymatous neuritis; the latter especially gives rise to grave and obstinate palsies, while slight paresis is the result of perineuritis.

There is one important symptom of neuritis: muscular atrophy, or dystrophie, which is sometimes precocious. Landouzy has made a complete study of it as regards the sciatic nerve, and he has made it a diagnostic sign

¹ Sometimes the pain is excessive, and in nervous persons is accompanied with agitation, convulsions, and delirium.

between neuritis and neuralgia. But from the absence of atrophy, the integrity of the nerve cannot be necessarily inferred. This atrophy is attributed to the suppression of the trophic influence exercised by the spinal cord upon the nerves and muscles.

Electrical exploration gives results which are often uncertain. In the early stage of acute neuritis, the electric contractility is often increased; it is null where the nerve fibres have undergone degeneration, and when there are paralysis and muscular atrophy, but if the degeneration is incomplete, the contractility is preserved. Generally, the gravity of the paralysis is in relation to the diminution of the electric contractility, so that electrical exploration may be useful for prognosis.

(3) *Neuritis of Mixed Nerves*.—The symptoms of neuritis of the sensory and of the motor nerves, may be combined when a mixed nerve is affected. But it must be remarked, that generally in inflammation of a mixed nerve, the disturbances of sensibility predominate, at least at the beginning. It is also to be remembered, that the symptoms which are observed, rarely remain limited to the territory of the inflamed nerve. Aside of the phenomena which may be directly referred to inflammation of a nerve, it is convenient to place those which are due to extension of the neuritis towards the spinal cord—to reflex excitation, which it is that causes convulsions and contractions; thus, a kind of writer's cramp has been seen to result from a neuritis of the radial nerve (Meyer); and general convulsions of various forms have been attributed to an analogous process.

Neuritis may be followed by the development of numerous *trophic disturbances*; but they are identical with those which we have already described as resulting from wounds of nerves; whether the neuritis is spontaneous or traumatic, the cutaneous, muscular, articular, and other alterations present the same characters, and depend upon the same pathological process.

Among the trophic disturbances, those must be distinguished which are due to nerve irritation (vesicles, herpes zoster, pemphigoid and eczematous eruptions, ulcerations, etc.), and those which are due to want of action, to nerve atrophy (glossy skin, ulcerations, alterations of the hair, nails, etc.).

Diagnosis of Neuritis.—The diagnosis of neuritis is often difficult, but nevertheless acute neuritis may be recognized, if there are observed spontaneous pain, sharp and continuous, pain provoked by pressure over a long portion of the course of the nerve, palsies, and precocious muscular atrophy. When there is a subacute or chronic neuritis, it is liable to be confounded with neuralgia, and all the more because the boundary between the two affections is not well marked; for the means of distinguishing them, the reader is referred to the section on neuralgia. Neuritis may be distinguished from muscular rheumatism by the fact that, in the latter, pressure upon the muscles is painful throughout their whole extent.

Prognosis.—The prognosis of neuritis should be always guarded, both on account of the duration of the disease, which may be long, and on account of the palsies and muscular atrophies which are its consequence, and which are persistent and difficult to cure. It must be added that the lesion may extend towards the nerve centres. According to Lereboullet, traumatic neuritis is, in this respect, less grave and less lasting than spontaneous or rheumatic neuritis.

Treatment of Neuritis.—Many of the indications which were given in considering the treatment of wounds of nerves, are applicable to neuritis in general. In acute neuritis, absolute rest of the limb should be directed, with

the use of antiphlogistics, leeches—though at times their bites are very painful—subcutaneous injections of morphia, and purgatives. In chronic neuritis, which often resists treatment, besides rest of the limb, revulsives should be employed—blisters, applications of iodine, or the hot iron—with the use of diaphoretics, hydrotherapeutic measures—ice, cold baths, douches, vapor baths, turpentine baths, etc.—antispasmodics, narcotics, and finally the continued current. It is of the highest importance that the general state of the patient should be inquired into, and, if he is arthritic,¹ as is frequently the case, that he should be given appropriate remedies in full doses.

NEURALGIA IN GENERAL.

The tendency to multiply operations upon nerves, particularly in neuralgias, requires the surgeon to have an exact knowledge of their symptoms and pathogeny, so that he may be able to determine the indications for operative intervention.

Neuralgia is a clinical syndrome, which belongs, indeed, to different morbid states of the nerves, of which some are not accompanied by any appreciable alteration, and of which others present various changes, too slightly marked for it to be possible to recognize them in the patient, or to classify them in other divisions of nerve pathology. Since the functional disturbances are the same, with the exception of some slight variations, in these different states, surgeons still join them together under the name of neuralgia, while at the same time endeavoring to discover all the signs which may permit their anatomical diagnosis to be established. This group is accordingly becoming smaller, with the progress of pathological anatomy and clinical analysis.

We admit then three principal varieties of neuralgia, the symptomatic, the reflex, and the idiopathic. There is here no question except of the neuralgias of the nerves of animal function.

Every pain is not a neuralgia. This is a sharp pain, spontaneous, occurring in paroxysms, remitting, and situated over the course of the nerves.

Etiology of Neuralgia.—The causes of neuralgias may be divided into predisposing causes, general causes (the diathetic and dyscrasic causes of Hu-
chard), and determining causes.

(1) *Predisposing Causes.*—Neuralgias are exceptional during infancy, frequent from twenty to sixty years of age, and rare beyond this time of life. The female sex seems to furnish a predisposition, and heredity also plays a certain part, by giving to the descendants a constitution favorable to the development of neuralgia. Persons of a lymphatic, and those of a nervous temperament, are predisposed. Certain physiological states, such as menstruation and pregnancy, also predispose to neuralgias. Occupations which expose to sudden changes of heat and cold, damp and badly situated dwellings, and certain states of the atmosphere, are again predisposing causes. According to Weir Mitchell, the pains are rather connected with the lowering of the atmospheric pressure (in storms, for example), than with changes of temperature, but moisture of the atmosphere continues to be the most effective cause; the influence of atmospheric electricity is yet to be investigated.

(2) *General causes* may give rise to neuralgias which are described by Hu-
chard under the name of diathetic, dyscrasic, and toxic neuralgias; these

¹ [See Vol. I. p. 315.]

appear to depend upon an alteration of the blood. "The blood, that regulator of the nerves, is deprived," he says, "of a certain number of globules; it reacts upon the nerves, and determines an exaltation of their properties."

These general causes are met with in anæmia, in chlorosis, in hysteria, in pregnancy, in lactation, in convalescence, in cachexias, such as syphilis and malaria, in poisoning by lead and by mercury, in Bright's disease, in diabetes, in influenza, in catarrhal fever, in measles, etc., and often in arthritis¹—rheumatism and gout.

(3) *Determining causes* are divided into peripheral causes, which act upon the nerves; central causes, which act upon the nerve centres; and causes which act at a distance, or by reflex action.

The *peripheral causes* include all the causes of traumatism of the nerves themselves, which we have already studied, and which give rise to *traumatic neuralgia*, which may often be attributed to a congestion, or to an inflammation of the nerves. They include also foreign bodies in the nerves, and diseases and tumors of these structures; the imprisonment of a nerve in a mass of callus, its compression by cicatricial tissue or by eburnation of bone-structure—neuralgic osteitis (Gosselin), neuralgia of edentulous persons (Gross).

To these must be added the alterations of the nerve brought about by lesions of the neighboring parts; and, finally, cold, which often plays an important part in the development of certain neuralgias, particularly among arthritic subjects (rheumatic, neuralgic).

The *central causes* include the lesions of the nerve-centres or of their membranes (tumors, etc.).

Reflex neuralgias are brought about by disease of a more or less distant organ. On this subject Huchard says, as follows: "In consequence of a sympathy existing between deep-seated organs and the parietes which cover them, very varied internal affections, painful or not, cause in the nerves of the walls the same morbid impressions which the visceral ramifications have undergone." To this class of neuralgias belong the lumbo-abdominal and other neuralgias which are seen in affections of the uterus or ovaries, in orch-epididymitis (Mauriac), etc. There might perhaps be included here, some of the *precocious, secondary, traumatic neuralgias* of Verneuil, which manifest themselves at the beginning of the reparatory process, and which will be again referred to. They are to be distinguished from *primary, traumatic neuralgias*, resulting from nerve-wounds, and from *tardy, secondary, traumatic neuralgias*, which occur after the work of cicatrization is completed, as, for example, in stumps.

Symptoms of Neuralgia.—The essential, and often the only, symptom of neuralgia is *pain*; and a distinction must be made between *spontaneous* pain and the pain caused by *pressure*; the former often presents itself under two forms; a continuous pain, and a remittent pain.

Continuous pain manifests itself by a sensation of tension, of pressure, and of aching; it affects by preference certain special foci, which then form the points of departure of the remittent pains.

Remittent pain sometimes presents a regular periodicity (intermittent pain); it is acute, and shows itself under the form of paroxysmal pain, throbbings, tearings, prickings, burnings, electric shocks, and painful jerks. It shows itself in paroxysms, during which the pains recur several times in a minute, or only once, twice, or three times in a quarter of an hour, etc. The whole duration of the paroxysm is extremely variable—a few minutes, some hours,

¹ [See Vol. I. p. 315.]

or several days, etc. When these pains come very close together, the patients feel disturbed, and there is a more or less intense anxiety, with insomnia, while the general state may end by being changed and presenting a kind of acquired nervousness. Sometimes the pains diminish, or even disappear, when the patient is engaged in important or forced occupations. These remittent pains have foci where they remain fixed during the same paroxysm, or during a part of its duration; at other times they are accompanied by painful irradiations. In other cases the foci change their seat, and move either towards the roots of the nerves (ascending neuralgia of Cotugno), or, more frequently, towards their extremities. In a word, the change of place of the foci does not follow the law which directs the propagation of the peripheral impressions; it does not generally follow the direction of the nervous influence; though we know, it is true, from the experiments of Bert, that the sensory nerves are capable of transmitting impressions in both directions. It has been said, following Valleix, that these foci are precisely the seats of pain (*points douloureux*) which are revealed by pressure; but although this may be true for a great number of cases, it is not always so.

In regard to the location of the darting pains, this varies; sometimes the darting is felt in the affected part; sometimes it takes the form of flashes (lightning pains), which follow the course of a nerve branch; sometimes there are several painful irradiations starting from the same point.

Pain upon Pressure.—Pressure exerted by a large surface, such as the palm of the hand, generally allays the pain; by pressing with the point of the finger, on the other hand, there is brought out along the course of the nerve, at one or several points, a pain which is at times very sharp; if the pressure is repeated, however, only a very slight pain is ultimately caused. Pressure exasperates the continuous pain, and occasionally determines an explosion of the darting pains.

According to Valleix, the *points douloureux* are at the points of emergence of the nerve-trunks; at the points where they become superficial; at the points where the nerve-filaments traverse the muscles or the aponeuroses; and at the points where the nerve-branches are finally distributed to the integument. The same author thought that the pain of neuralgia affected exclusively the subcutaneous nerves, or those of tactile sensibility; but pressure over the deep nerves is often painful.

The points painful to pressure (*points douloureux*) are frequently absent. Trousseau proposed to substitute for them *spinous points* (*points apophysaires*),¹ but they have nothing characteristic in neuralgia, not even in intercostal neuralgia, where they may be wanting.

The number of painful points over the course of a nerve varies in each case. They may be one or two centimetres [half or three-quarters of an inch] in diameter; sometimes their boundaries are very distinctly circumscribed, at other times more diffused. The intensity of the pain on pressure is, generally, in relation to that of the spontaneous pain. Not only pressure, but efforts and movements of the patient, and the contact of hot or cold bodies, bring back the darting pains.

Concomitant Symptoms.—During the paroxysms, there may be observed, injection of the affected parts, congestion, increase of the secretions (mucus, tears, sweat, etc.), cutaneous hyperæsthesia or anæsthesia, and convulsive movements (*tic douloureux*); if any paralysis appears, it is because there is a grave lesion of the nerve.

Besides these local disturbances, there may be experienced general sensa-

¹ [The *spinous points* of Trousseau are situated over the spinous processes of the vertebræ, corresponding to the point of exit of the nerve from the intervertebral foramen.]

tions of irritation, anxiety, vertigo, and unfitness for work; at the end of the attacks, the patient sometimes passes a large quantity of watery urine.

When the neuralgia is chronic, trophic disturbances may appear; there have been noted, a hypertrophy of half the face (Axenfeld), falling of the hair, and, in recent times, increase of the subcutaneous fat and muscular atrophy; but then there is neuritis or a spinal lesion (Landouzy, Fernet).

Finally, the general health of the patients may be altered, they become impressionable and melancholy, and their digestive functions are impaired.

These symptoms of neuralgia may be met with in all the etiological varieties, but the *precocious, secondary, traumatic neuralgias* of Verneuil present certain peculiarities.

These show themselves generally, according to this author, apart from all material lesion of the nerves, after the cessation of the primary pain caused by the injury and the nerve lesion, and as early as the beginning of the reparative process in the wound, that is to say, during the first week; they differ from the tardy neuralgias which appear after cicatrization (*neuralgias of cicatrices and stumps*).

These neuralgias may be accompanied by clonic contractions, contractures, paresis, congestion, ecchymosis, and hemorrhage from the granulations; sometimes the wound assumes a diphtheroidal aspect; finally, general phenomena, such as fever and vomiting, may be met with.

Verneuil distinguishes several varieties of this form of neuralgia, according to their seat: (1) Local pain, limited to the traumatic focus; (2) Local pain, with peripheral irradiations; (3) Local pain, with peripheral insensibility and distal manifestations; (4) Local, peripheral, and distal pain, all at the same time; and (5) Local insensibility, with pain only at a distance.

These neuralgias are intermittent, and are relieved by the sulphate of quinine.

The *course* of neuralgia is generally irregular. Its onset may be sudden, or it may be gradual, and preceded by a sensation of uneasiness. The attacks are of variable duration; they are remittent, and sometimes intermittent, as in malarial poisoning; the painful paroxysms, the darting pains which constitute them, occur with greater or less frequency, and are more or less violent.

The *duration* of neuralgia may be a few days, several months, or several years; the study of its causes accounts for all the variations here noted; neuralgia is then either evanescent or persistent.

The *termination* of neuralgia is never fatal, but it may change the general state of the patient, react upon his moral nature, and drive him to suicide. In some cases neuralgia disappears gradually, exhausting itself as it were; sometimes at the moment of its definitive disappearance, or upon the cessation of a paroxysm, there are observed so-called critical phenomena—cutaneous eruptions, diarrhœa, profuse diuresis, etc. Neuralgia generally disappears when an intercurrent disease supervenes. In other cases its disappearance is coincident with the occurrence of congestive metastases, or more often with the development of other neuralgias.

Pathological Physiology.—The pathological physiology of neuralgia is not yet completely known. What is the *cause of the pain*; in what does it consist? Is it a special excitation of the properties of the nerve, a particular weakening, or a modification of conductivity? We do not know. But it seems certain that there is no single lesion, nor one cause always alike, to explain the pain. Rigal admits a lesion of the nervous elements, or a disturbance in the molecular interchanges. Ouspenky, a partisan of the central theory of neuralgia, supposes that each pain is provoked, or at least accom-

panied, by the formation of products of the metamorphosis of the nervous system, and by their influence upon the latter.

What is the *seat of neuralgia*? "To what kind of lesion of the nervous system are" neuralgias "due," says Vulpian; "where are these lesions located? Are we concerned with a congestion, or with an inflammatory irritation of the affected nerve? Is it the nerve itself which is altered? Is it its peripheral extremity? Is it its central extremity? Is it the nerve-centre? While neuralgias," he adds, "have, according to various pathologists, their ordinary seat at the periphery of the nerves, or in a more or less extended portion of the nerve-trunk, I believe that, in a large number of cases, the alteration which causes these affections resides in the central extremities of the nerves; most frequently, perhaps, in the spinal cord or in its membranes."

Two theories, in fact, have been proposed on the subject of the localization of neuralgias:—

(1) The *central theory*, which is sustained by Vulpian, who would place the lesions of neuralgia in the spinal cord, or in its membranes; and by Anstie, who admits in every neuralgia a lesion of the sensory roots of the nerves in their intra-spinal course, and of their gray nuclei, etc.; and

(2) The *peripheral theory*, sustained by Axenfeld and Huchard, according to which neuralgias have their seat in certain only of the sensory fibres which compose the nerve-branches, and occupy the entire length or some isolated points of their course. In a great number of cases the seat of the pain is real and not virtual; that is to say, the pain is produced in the very places where the patients feel it, and is not simply felt as if it were produced there.

But, nevertheless, the spinal cord plays a part in the production and generalization of neuralgic pains, and in the development of peripheral, painful irradiations. The lesions, from being peripheral at the beginning, may become central, as we have already seen in regard to neuritis. The painful excitations originating from the periphery and from the diseased nerves, reach the spinal cells—sensory nuclei of Clarke's columns (Pierret)—and by their intervention determine these multiple irradiations. Finally, the spinal cord intervenes directly in trophic disturbances and in vaso-motor palsies.

The discovery of the *recurrent fibres* has thrown a new light upon this subject. It explains why the influence of the sensory nerves extends beyond their anatomical zone of distribution; any particular region may be connected with others by several nerve-trunks or branches, owing precisely to the existence of these fibres ascending in the course of neighboring trunks. It was thus that, in one case, Tripier relieved a neuralgia of the ulnar nerve by compressing the musculo-cutaneous. This also accounts for the failure of certain neurotomies.

Finally, Cartaz explains by the recurrent fibres, both the existence of the *points douloureux* and the seat of neuralgias. Indeed, according to the investigations of Arloing and Tripier, the recurrent fibres on the face, for example, stop below the bony foramina, to expend themselves in the neighboring tissues. Now, these points, provided with a rich nervous network, correspond precisely with the *points douloureux* of Valleix. According to Cartaz, certain so-called functional neuralgias are caused by *peripheral neuritis* of the nerve-trunks, filaments, or terminal networks.

In conclusion, the three following propositions, established by Huchard, may be admitted:—

- (1) Certain neuralgias are primarily peripheral in their seat, and remain always peripheral during their whole evolution.
- (2) Others may be primarily peripheral, and become central secondarily.
- (3) Others, finally, are primarily central.

Diagnosis of Neuralgia.—The diagnosis of neuralgias presents great difficulties, as regards their cause and intimate nature; I shall try to state the matter as exactly as possible. Let us first recall the characteristic signs of neuralgia.

Neuralgia is characterized by a spontaneous, remittent pain, often grafted upon a dull, continued pain. It is seated along the course of the nerves, and radiates generally from the centre towards the periphery. The pain frequently reappears upon pressure at certain ascertained points, and is accompanied by certain functional disturbances.

(1) It is first necessary to diagnosticate neuralgic pains from *other pains of central or peripheral origin*.

Myosalgia or *myalgia* occupies, not the course of the nerves, but that of the muscles; it is excited by each contraction of the affected muscle, and presents neither irradiations nor paroxysms.

The *osteocopic pains of syphilis* are generally symmetrical.

The *pains of chronic poisoning by alcohol or by mercury* are most frequently continuous, and limited to the peri-articular structures of the extremities.

But it is especially in regard to the pains of *posterior myelitis* and of *locomotor ataxia* that the diagnosis should be exact. These pains are not seated over the course of the nerve-trunks or branches, and are not increased by pressure. They consist in a series of dartings which occur in a circumscribed region, and sometimes traverse from above downwards the whole extent of the limb. They are comparable to the sensation produced by the electric spark (*lightning pains*); at other times they are more persistent, and give the sensation of a gimlet (*boring pains*) in the bones or articulations.

Spinal irritation presents *spinous points* (*points apophysaires*) which are characteristic of cutaneous hyperæsthesia, with visceral congestions and parietic disorders of the lower extremities.

Neuralgia sometimes occurs *in an epileptic*, and then becomes the occasion of attacks of diverse nature. These phenomena must be carefully investigated by a minute examination of the patient. In a case of neuralgia of the inferior dental nerve in a male adult, subject to attacks of coma, death occurred suddenly a few hours after resection of the nerve. The patient's physicians had advised against any operation, fearing the occurrence of some accident, but had finally yielded to his reiterated requests.

(2) The neuralgia being recognized, it is necessary to seek to *ascertain its cause*, peripheral or central.

There may be *congestion of the nerve, or of its centre of origin*. Gubler considers malarial and rheumatic neuralgias to be due to congestion.

In *neuritis*, the pain is continuous, and is increased by pressure over a long extent of the course of the nerve. Paroxysms occur, especially upon movement, or upon external excitation; cutaneous hyperæsthesia occurs more frequently; anæsthesia is earlier developed. Rapid muscular atrophy supervenes, with deposit of subcutaneous fat and persistent trophic disturbances, those of neuralgia being especially functional disturbances. Finally, neuritis has a cyclical evolution. To neuritis belong most of the traumatic neuralgias and many of the arthritic and rheumatic neuralgias.

Compression of nerves by tumors, by indurated tissue, by cicatrices, or by callus, may cause neuralgias which run a chronic course, are continuous, are accompanied by trophic disturbances, and present, in a word, the symptoms of what Hallopeau has called "*névralgies-névrites*." Neuromata and so-called "*irritable*" tumors are also accompanied by neuralgia (neuralgia of stumps).

What is the *exact seat of neuralgia*? Must we admit the existence of a lesion of the nerve-trunk and its terminal branches, or of its sources of origin in

the spinal cord? The surgeon should inquire whether the neuralgia has not as its point of origin a lesion situated outside of the nerve, in its neighborhood, or in a distant organ (reflex neuralgia).

Is there, finally, simply an *essential neuralgia*—a painful neurosis of the sensory nerves? (Hallopeau.) In these cases, the beginning is sudden, there is no continuous pain, nor pain on pressure; the dartings are of extreme severity and of short duration.

(3) Finally, it will be necessary to endeavor to recognize the *nature of the neuralgia*—the nature of the lesion which determines its production. Is the patient arthritic, rheumatic, or gouty? Is there a complication of chloranæmia, malaria, syphilis, or certain chronic poisonings, etc.? By such inquiries it can be ascertained whether the neuralgia is or is not dependent upon a general, constitutional condition.

Prognosis of Neuralgia.—The prognosis varies with the variety of the neuralgia and with its cause. It is gravest in neuralgias of central origin, and where there are positive nerve-lesions; the neuralgia may under such circumstances be persistent and even incurable. Neuralgias from congestion are less serious, though occasionally they are very persistent; all neuralgias are of this character in old, feeble, and neuropathic individuals.

Neuralgias are subject to frequent relapses, especially when they are dependent upon constitutional conditions. Syphilitic and malarial neuralgias are the most amenable to treatment.

Treatment.—Three indications are to be fulfilled: (1) To combat the general constitutional state; (2) To combat the local nerve lesion; and (3) To combat the pain.

(1) *General Medication.*—This addresses itself to the nature of the neuralgia, which is often, as we have seen, dependent upon a general, constitutional condition. This condition must be modified, if it is wished to obtain the disappearance of the neuralgic attack, and to prevent the recurrence of new attacks. General medication has often succeeded when all other measures have failed. Moreover, when it is indicated, care should be taken to employ it at the very beginning of the treatment. The medication varies according to the nature of the constitutional state, according as there is arthritism, malaria, syphilis, etc.

In addition to this general medication, some general rules of hygiene must be enforced: a non-exciting diet; abstinence from coffee, tea, and alcohol; mental repose; avoidance of sexual relations; exercise in the open air; hydrotherapeutic measures—anodyne baths, cold baths, sea baths, etc.

The form of hydrotherapy to be employed, and the nature of the baths, will vary according to the general conditions; warm and cold douches, transition douches, vapor baths, fumigations, hot-air baths, Moorish baths, etc.

(2) At the same time that general remedies are administered, it is necessary to *control the local nerve-changes*. Surgical interference is necessary at the very beginning if there is a mechanical cause, such as the presence of a foreign body, or compression and irritation of the nerve by an exostosis, by callus (in which case the inclosed nerve must be released), by a cicatrix, or by a tumor of the nerve or of its neighborhood.

If congestion, or if neuritis, exists by itself, or persists, cut-cups may be employed, revulsives over the course of the nerve, blisters, irritant applications, the hot iron, cauterizations with sulphuric acid (which, however, must be used cautiously), local douches, filiform douches, etc. Aquapuncture has been recommended (Siredey), as have irritant hypodermic injections—injec-

tions of nitrate of silver or of sea-salt (Luton); electricity may be usefully employed.

(3) To the two forms of medication already described there must be added that which has for its end the *combating of pain*. This variety of medication always plays an important part, and sometimes is employed alone when there are found neither morbid constitutional states nor local nerve-changes. There is generally too great a tendency to rely upon this form of treatment, while the others are more or less completely neglected. It renders good service, but the former only are truly curative.

To relieve the pain of neuralgia, anodynes may be employed by hypodermic injection, as topical applications, and by internal administration. The hypodermic injections most often employed are those of muriate of morphia, from five milligrammes ($\frac{1}{12}$ grain) upward; of chloroform (Bartholow, Besnier) in doses of from one to three grammes (15 to 45 minims); and of atropia, in doses of from one to two milligrammes ($\frac{1}{60}$ to $\frac{1}{30}$ grain). The latter remedy is somewhat dangerous. Morphia has also been administered by the endermic method, by means of a small blister. Different topical remedies have been applied, some with opium for a basis, such as liniments containing laudanum; applications to the skin of chloroform and ether have also been employed, as have anodyne ointments, ointments of veratria and of morphia, etc. Finally, anodynes are administered internally: opium, laudanum, chloral, aconitia, bromide of potassium. The sulphate of quinine is very efficacious in the secondary traumatic neuralgias (Verneuil). Inhalations of chloroform and ether are also employed; but they have frequently been the cause of accidents.

Armaingaud has obtained successful results by the employment of revulsives, blisters, the hot iron, etc., over the position of the painful spinous points. Huchard attacks these with the ether spray applied over the vertebral column.

Finally, if all medication fails, *surgical intervention* becomes necessary. An energetic compression over the course of the painful nerve has sometimes been of service. But recourse has been especially had to section or resection of the nerve, and to elongation, with or without crushing. These operations will be studied hereafter. In recent times the boldness of operators has extended to tearing out the branches of the trifacial, a heroic operation which might prove dangerous by irritating the ganglion of Gasser, or the central origins of the nerves.

TUMORS OF NERVES.

Odiër, of Geneva, in 1803, described under the name of *neuromata*, all tumors developed in the course of the nerves, whatever was their structure. In 1822, Aronssohn, following Camper and Alexander, endeavored to divide them into two principal classes, according to whether the tumor grew from the medullary structure of the nerves, or from their interstices and from their neurilemma; but his attempt remained without effect, the more so that in 1825 appeared the work of Descot, who considered all neuromata as being of a cancerous nature, an opinion which was adopted by a great number of surgeons.

In 1853, Houel, recording a case of multiple neuromata, admitted two principal varieties: fibrous tumors and fibro-plastic tumors; but Lebert, in the report he made in regard to Houel's work, considered neuromata to be all formed by fibrous tumors.

In Germany, Fuhrer and Virchow found that certain neuromata contained

nerve-fibres, and in 1865 Foerster recognized two varieties of tumor of nerve-tissue—one formed by a substance analogous to the gray substance of the brain (medullary neuroma), the other constituted by nerve-fibres (fasciculated neuroma). This view was sustained by Virchow in his "Treatise on Tumors."

At the present time, notwithstanding the progress of pathological anatomy, it is not yet possible to give an exact classification of the tumors of which the nerves may be the seat; the attempt may be made, however, to frame a kind of outline which will serve to classify published cases; but it must not be forgotten that a certain number of these are still the subject of discussion, so that their actual nomenclature is not definitively settled. To the difficulty of making an anatomical diagnosis, not only at the bedside of the patient, but even by naked-eye and microscopical examination, must be attributed the want of precision which science presents upon this question.

In the following pages, tumors of nerves will be described as being of three principal varieties: (1) those which are formed by the nerve-tissue itself; (2) those which are formed from the connective tissue of the nerves; and (3) the cancerous degenerations of nerves.

In accordance with the principles of classification of tumors adopted in general pathology, I shall reserve the name *neuromata* for tumors which are constituted of nerve-tissue of new formation; the other tumors of nerves will be designated, as is done with tumors of other organs or tissues, by the name of the predominant tissue in the tumor. In connection with this subject, we may recall the words of Cornil and Ranvier, "that for a tumor to merit the name of neuroma, it does not suffice that it contains nerve-fibres; it is further necessary that the number of these latter allows it to be supposed that it is a new formation of nerve-elements."

In regard to the *painful subcutaneous tubercle*, I shall describe it separately; if sometimes it has been found constituted of nerve-fibres (L. Labbé, Legros), more often it has been exclusively fibrous; moreover, it is not situated in the course of a nerve-trunk or of an important branch, and in reality it constitutes, as we shall see presently, a quite distinct clinical variety.

It is only the anatomy of the several forms of nerve-tumor that demands a separate description for each; of the other parts of their history a collective study will suffice, the peculiarities of each variety being indicated when necessary; in this second part of the investigation, the term *neuroma* will often be employed as synonymous simply with nerve-tumor.

ANATOMY OF NERVE-TUMORS.—Tumors of nerves, as has been already said, are divided into three principal varieties: (1) Tumors formed by the nerve-tissue (*neuromata*); (2) Tumors formed from the connective tissue (*fibromata*, *sarcomata*, *myxomata*, *cysts*); and (3) Cancerous and epithelial degenerations.

I. NEUROMATA.—The tumors constituted of nerve-tissue of new formation are divided by German authors into two varieties, viz.: (1) *Medullary or cellular neuromata*, consisting of ganglionic cells, and (2) *Fasciculated or fibrillar neuromata*, formed of nerve-fibres. A third group may be added, viz.: (3) that of the *plexiform neuromata*.

(1) *Cellular neuromata.*—These are met with in the nerve-centres, and sometimes in encephaloceles; in one case, a tumor of this kind was found in a nerve-ganglion. According to Virchow, there may be a formation of nerve-substance in encephaloceles, and in congenital tumors of the sacrum and coccyx; as to the formation of normal ganglia upon the course of nerves, it is far from being established. Possibly a hyperplasia of undescribed, though pre-existing, ganglia may be admitted. Indeed, the existence of these neuro-

mata upon the peripheral nerves is not demonstrated, and it is now long since that the opinion of Serres has been abandoned, which considered the multiple tumors of nerves as ganglia of new formation, and described the affection under the name of *neuroplasia*.

It may be said, however, that Foerster admitted their existence, and that Robin has found, in a case of alteration of the solar plexus, a new formation of nerve-cells.

(2) *Fibrillar neuromata*.—These are constituted of nerve-fibres of new formation, and are divided into two kinds, which may be considered as two stages of the same affection; the *myelinic neuromata*, formed by fibres with myelin, and the *amyelinic neuromata*, formed by fibres without myelin. The existence of these latter neuromata is contested by several authors, on account of the difficulty of distinguishing the fibres of Remak. Billroth says that under this name have been described fibromata, which constitute certain varieties of multiple nerve-tumors. We should then be as yet reserved upon the subject of the existence of amyelinic neuromata (Cornil and Ranvier).

The *myelinic fibrillar neuromata* have, for their type, the *neuromata of stumps after amputation*. Apart from these cases, they are rare, though this is not the opinion of Foerster and Virchow, who place in this variety most of the fibromata of nerves, which growths they resemble when sections are examined with the naked eye.

These tumors are further described under the name of *traumatic neuromata*, for they are observed, not only in stumps after amputation, but after wounds of nerves, ligations of nerves, and even, according to Tripier, as a result of subcutaneous nerve-lesion (Weissmann, Dehler); they thus constitute certain painful subcutaneous tubercles (L. Labbé, Legros), and also plexiform neuromata (Verneuil).

The type of these tumors is the *amputation-neuroma*. It has its seat upon the extremity of the divided nerve, at a greater or less distance from the cicatrix, according as the nerve has retracted, or has been cut at a higher or lower point. Its shape is oval, and often flattened, and it is continuous, directly or by means of radicles, with the cicatrix.

The size of these neuromata varies from that of a large pea to that of a hen's egg (Hutin); they are grayish, more or less vascular, firm, and elastic, and they present, upon section, the characters of compact fibromata. With the microscope, it is seen that they consist of interlacing and twisted nerve-fasciculi, inclosing myelinic nerve-fibres. Between them is found a variable amount of connective tissue. Sometimes the nerve-tissue predominates, sometimes the connective tissue. Foerster seems to believe that these nerve-fibres are not continuous with those of the nerve, and that they constitute a separate system of fibres, originating from the connective tissue. Cornil and Ranvier think that the twisted fibres have their origin from the old fibres, and are continuous with them.

Their mode of development may be understood by referring to the phenomena of regeneration of nerves. Cornil and Ranvier express themselves upon this subject, as follows:—

“In the end of the central segment, two or three days after the operation on the rabbit, the axis cylinders become hypertrophied in the neighborhood of the section, they seem then to be composed of fibrils (elementary fibrils), but subsequently they divide in the direction of their length, budding and extending into the cicatricial band. These nerve-fibres, then without medullary matter, which result from the budding of the old axis-cylinders, divide and subdivide in such a manner that a single nerve-fibre may give origin to a more or less considerable number of new nerve-fibres. Afterwards these

nerve-fibres become covered with a medullary sheath, and assume all the characters of myelinic nerve-fibres."

From what has been said, it can be seen that, without denying the genesis *in loco* of the nerve-fibres (Virchow), several authors admit that most often they trace their origin from the budding of the axis-cylinders; this also accounts for the change of amyelinic into myelinic fibres.

Several neuromata may be united so as to form a globular mass, or the different neuromata of a stump may be joined by loops (Larrey). Virchow admits that tumors of the same nature may be developed along the course of the nerves in the neighborhood of other chronic changes.

Reuillet has published the case of a man thirty-five years old, who at the age of six years had a fracture of the right humerus with a wound; at the autopsy there were found an increase in size of the cervico-dorsal nerves, which presented tumors along their course, and an increase in size of the ganglions of the roots of the nerves, and of the spinal cord in the cervico-dorsal region. There were secondary lesions of the articulations and of the muscles. These changes in the nervous system were attributed to an irritation of the peripheral nerves, which had caused hypertrophy and hyperplasia of the nerve-fasciculi. Tripier has pointed out that in this case the tumors were formed by medullary fibres due to a multiplication of the axis-cylinders.

(3) *Plexiform Neuroma*.—Under the name of *plexiform neuroma*, or *cylindrical neuroma*, Verneuil described, in 1861, a variety of congenital tumor which he had observed for the first time in 1857, with Depaul; the case was one of tumor of the nucha, with hypertrophy of the skin, which formed a large fold. The mass of the tumor described by Verneuil, was formed of elongated nerves, twined around like a bunch of varicose veins, and presenting anastomoses, with enlargements analogous to neuromata. These hypertrophied cutaneous nerves made up two-thirds of the mass of the tumor (*cirroid neuromata* of Burns and Rizzoli). Among the nerve-trunks, some were formed of one, two, or three nerve-fibres, and of fibro-plastic tissue; others were almost exclusively composed of nerve-fibres, with a double or single contour.

In 1859, Guersant presented to the Society of Surgery a young girl, who had, in the mastoid region, a congenital tumor of the same nature, as was demonstrated by the anatomical examination made by Verneuil. Alongside of these cases should be placed those of tumor of the skin described by Valentine Mott (1854) under the name of *pachydermatocoele*, and those which Gayet has reported under the name of *general connective-tissue hypertrophy*. Billroth, in 1869, published a case of plexiform neuro-fibroma of the upper eyelid and of the temple.

Numerous cases have since been added to the above; but authors are not yet agreed as to their interpretation. Virchow joins in one and the same category the cases of Verneuil and those of Valentine Mott, and refers them to *congenital elephantiasis*. He considers as cases of *acquired elephantiasis*, a case of Verneuil's, of plexiform neuroma of the prepuce, and two cases of Chelius and of Barkow, in which, following an injury, there supervened a swelling of the inferior extremity with chaplet-like hypertrophy of the tibial nerve. This form of nerve-hypertrophy might perhaps be compared with the case of Reuillet and Tripier, cited above in connection with neuromata properly so called.

Cartaz, in 1876, gave a description of plexiform neuroma based upon thirteen cases. The tumor presents itself in the form of a diffuse, flabby swelling, in the midst of which are felt cords which glide from under the finger;

the skin is thickened. The tumor is constituted of hypertrophied, tortuous nerve-trunks, bound together by connective tissue. The connective-tissue hypertrophy surrounds the nervous element, and may cause it to disappear; this form of tumor may thus gradually become assimilated to a fibroma.

In a case of plexiform neuroma recorded by Winiwarter, there were at the same time a development of diffuse fibromata in the nerves, with formation of new nerve-fibres, and, in a part of the tumor, the formation of a sarcoma at the expense of the nerve-trunks.

R. Marchand, in 1878, in a *Memoir upon the Plexiform Neuroma*, said that this name might be replaced by that of *cylindrical fibroma of the nerve-sheaths*. According to this author there is no multiplication of nerve-fibres, which, on the contrary, undergo atrophy or disappear.

Finally, quite recently (1882), in the Society of Surgery of Paris, after the presentation by M. L. Labbé, of a patient who was considered to have an elephantiasis of the face, a discussion arose as to the nature of the tumor. Verneuil regarded it as a plexiform neuroma; Trélat, as a degenerated, congenital erectile tumor; Desprès, relying upon the observations of Ollard, considered it a soft elephantiasis; Guéniot recalled the fact that he had presented, under the name of "hypertrophic nævus," a tumor which had the same appearance, and which had been found to be constituted of the elements of the skin and of the cellulo-adipose tissue.

As will be seen, it is difficult to decide definitively the place in nosology which should be occupied by the variety of tumor described under the name of plexiform neuroma.

The alteration of the skin had led some authors to consider the neuroma as a primary lesion of the integument, extending secondarily to the nerves of the region; but as Cartaz points out, the inverse hypothesis, that of a primary hypertrophy of the nerves and secondary implication of the neighboring tissues, may also be sustained. If anatomical examination has given different results in different cases, this is owing to the tumors having been examined at different periods of their development, the nerve-elements undergoing atrophy and disappearing in consequence of the growth of the connective tissue.

The position here assigned to the plexiform neuroma, between the true neuroma and the nerve-tumors originating in the connective tissue, seems then justifiable, at least for the present. The plexiform neuromata are quite often indolent, congenital tumors, of slow development; most surgeons who have observed them recognize the necessity of their removal, on account of their progressive development and of the possibility of their degeneration, as in Winiwarter's case.

From twenty-eight cases of plexiform neuroma collected by Poincot, it is found that the frequency of the lesion continues to increase from birth to the age of twenty years; it then diminishes, and does not again increase until from forty to fifty years. These tumors are not the seat of any pain.

II. TUMORS FORMED AT THE EXPENSE OF THE CONNECTIVE TISSUE OF THE NERVE.—Besides neuromata, there are found in the nerves several varieties of tumor which have their origin in the connective tissue; these are *fibromata*, *sarcomata*, and *myxomata*; Virchow has added *gliomata*, or sarcomata of the neuroglia, the connective tissue of the nerve-centres, and *telangiectasic neuromata*, in which the vessels of the tumor occupy a predominant place.

The frequency and variety of the connective-tissue tumors, are explained by the abundance and varied forms of this tissue met with in the nerves. The nerves are surrounded by the neurilemma, a connective-tissue sheath which isolates them at the same time that it unites them to the neighboring tissues,

and which moreover sends prolongations into the interior of the nerve-trunks between the different fasciculi of which they are constituted. Each fasciculus is itself surrounded by another sheath formed of delicate connective-tissue fibres (*perineurium* of Robin, *lamellar sheath* of Ranvier), which also sends prolongations into the interior of the fasciculus; finally, the nerve-fibres are surrounded upon all sides by thin connective-tissue fibres.

(1) *Fibromata of Nerves*.—The fibromata of nerves are more frequent than the sarcomata. Foerster and Virchow regard the cases published under this name as cases of neuromata with amyelinic fibres; Lebert grouped together under this name the majority of nerve-tumors. The fibromata are developed at the expense of the connective tissue of the nerve, from either the neurilemma, the perineurium, or the interfibrillar tissue, and even the sheath of Schwann and its nuclei may, according to Christol, contribute to the formation of the new fibrous tissue. It was upon this difference of origin that Lebert based his classification of neuromata into (1) interfibrillar, or central neuromata; (2) peripheral neuromata, and (3) mixed neuromata. As a result of inflammation of nerves, there are sometimes found upon their surface, small, circumscribed, fibrous tumors, which are only the traces of a *chronic perineuritis*.

Fibromata of nerves are often solitary, but they may also constitute the tumors of nerves which have been described under the name of *multiple neuromata*. Their size also is variable, and they may reach large dimensions.

The tumor may be of a composite character. Cystic fibromata have been met with (Smith, Houel, Trélat); Poincot observed a tumor which included fibrous tissue, fibro-plastic elements, and cystic cavities. Fibromata are sometimes observed at the extremities of divided nerves, in the neuromata of amputations, which are generally considered as neuromata with amyelinic fibres. They constitute also a variety, or a stage, of the plexiform neuromata—cylindrical fibromata of the nerve-sheaths (R. Marchand).

The histology of these tumors is still incomplete, and I shall, therefore, give a summary of the results obtained by the examination of two varieties of fibroma.

Cornil examined a solitary fibro-myxoma of the sciatic nerve, removed by Trélat; in this case the fibrous element predominated, and the new tissue existed solely in the interior of the lamellar sheath; it formed a thick zone within this, and pushed away the nerve-fibres to the centre of the fasciculus. Each nerve-fibre was surrounded by a new production of connective-tissue fibrils; the sheath of Schwann presented a multiplication of its cellular elements. The medullary substance and the axis-cylinders were preserved intact. Motility and sensibility had been retained by this patient. The neurilemma took no part in the formation of the tumor. Cornil calls attention to the point of origin of this tumor in the intrafascicular connective tissue.

In the case of a patient whom I have still under observation, and in whom a great number of nerves present tumors, I removed two which had increased a little in size, and had become painful. Their histological examination was made by Variot, who found that these tumors were formed by the junction of small, distinct tumors, developed, as in the case of Trélat's patient, in the interior of the lamellar sheath, or of the perineurium, by the proliferation of the intrafascicular tissue. The nerve-fibres were driven back against the wall of the fasciculus, and had preserved their integrity.

(2) *Sarcomata of Nerves*.—Sarcomata of nerves are tolerably rare; their existence has been denied by Virchow, but it is established at the present day without contestation.

The size of these tumors varies, and they may attain large proportions; in a case of Marchand's, the tumor measured 16 centimetres ($6\frac{1}{4}$ inches) in diameter. Most frequently the tumor is solitary; in a patient of Winiwarter's, however, there were several similar tumors upon the branches of the brachial plexus, and the patient, moreover, succumbed to a generalization of sarcoma in the lungs. Sarcoma may present various changes, which, however, are those of sarcoma in general; granulo-adipose degeneration; formation of hemorrhagic foci; mucous infiltration (Muron).

The *fascicular sarcoma* is the most common variety (Marchand); next is the *fibro-sarcoma* (Sottas, Foucault, Lanelongue); the tumor may present one or several *cysts* (Marchand).

Sarcomata have been met with upon the branches of the brachial plexus (Winiwarter), upon the median nerve (Grohe, Volkmann, Lanelongue), upon the ulnar nerve (Verneuil, Demarquay, Foucault), upon the sciatic nerve (Verneuil, Marchand, Bouilly, Mathieu), and upon the posterior tibial nerve (Broca).

With the sarcomata should be joined the *gliomata* of Virchow, or *neuroglie sarcomata* of Cornil and Ranvier. The German author has observed this variety of tumor in the cranial nerves, and particularly in the auditory nerve, but not in the peripheral nerves, though he considers its existence in them as probable.

(3) *Myxomata of Nerves*.—According to Cornil and Ranvier, these are relatively quite frequent, and are presented under the form of transparent, gelatinous, usually lobulated tumors. They have been confounded with cysts (Wilms). They may present various modifications, constituting the *fibro-myxomata* (Dolbeau, Trélat), *cystic myxomata*, *lipomatous myxomata*, etc.

Myxomata have been seen upon the radial nerve (Wilms), upon the ulnar nerve (Lafargue), upon the posterior tibial nerve (Dolbeau), and upon the peroneal nerve (Virchow and Gutteridge).

(4) *Cysts of Nerves*.—We have seen that cystic cavities may be met with in fibromata and sarcomata, but cases of isolated cysts of nerves are rare; one was observed by Beauchêne, in 1810, a cyst of the ulnar nerve, and one by Bertrand, a cyst of the median nerve. Lockhart Clarke says that there is in the Museum of St. George's Hospital, London, a preparation of a cyst of the median nerve.

III. CANCER AND EPITHELIOMA OF NERVES.—The existence of primary cancer of the nerves, regarded as frequent by authors at the beginning of this century, is disputed at the present day, except in the case of the retina and in that of the optic nerve. Foerster, however, according to Cornil and Ranvier, has observed primary carcinomata of the nerves, which, being at first the size of lentiles, had caused by their development the complete destruction of the nerve.

Secondary cancer is met with quite often; it has been well studied by Cornil. The invasion of the nerve is effected in two ways: (1) By direct propagation, by continuity; and (2) By the formation of tumors more or less distant from the primary cancer. The tumors thus formed are small in size, and sometimes multiple; the lesions affect the neurilemma, the perineurium, and the nerve-fibres, which may be destroyed.

Cornil has especially studied secondary cancer of the nerves following cancer of the neck of the uterus and cancer of the breast, particularly of the scirrhus form; he has also observed it as a sequel of cancer of the retro-

peritoneal glands. He has found cancerous tumors in the femoral, the sciatic, and the intercostal nerves, and in those of the brachial plexus.

MULTIPLE NEUROMATA.—There may occur upon the nerves multiple tumors of variable structure and benign nature, which are designated by the name of multiple neuromata.

The distribution of multiple neuromata varies in different cases. Lebert recognizes, in regard to this point, three varieties: (1) tumors developing themselves upon several points of the same nerve, which assumes the appearance of a chaplet, or upon several of its branches; (2) tumors seen upon the nerves of one and the same region; and (3) tumors observed upon the nerves of very different regions, or neuromata of general multiplicity. Lebert unites the first two varieties under the name of neuromata of local multiplicity.

I. NEUROMATA OF LOCAL MULTIPLICITY.—(1) *Multiple Neuromata of a Single Nerve.*—Examples of these are rare; Poincot has collected eleven cases in which the tumors were seated upon the median nerve or other nerve of the arm (A. Bonnet, Piorry, Roux), upon the sciatic nerve (Louis), upon the posterior tibial nerve (Dupuytren, Van der Byl, Dolbeau, Polaillon), upon the pneumogastric nerve (Sottas), or upon the great splanchnic nerve (Lobstein).

(2) *Multiple Neuromata of a Region.*—These have been especially observed in the upper extremities, and upon the cutaneous filaments of the forearm and the hand; such was their seat in the cases of Stromeyer, Robert, Jacquart, Blasius and Volkmann, Blasius, Leboucq, Huguier, and Nélaton. E. Home met with them upon the brachial plexus; Lancelongue (of Bordeaux) upon the median and ulnar nerves at the upper part of the forearm; Gunsburg upon the branches of the sacral plexus; Virchow upon the saphena nerves; and Heinenche upon the intercostals.

Virchow and Poincot connect with this variety of multiple neuromata the plexiform neuromata which have already been described.

II. NEUROMATA OF GENERAL MULTIPLICITY.—In this variety, the tumors may be met with in different regions and upon various nerves. Cases of this kind are yet quite rare; Poincot has been able to collect thirty-one. This disease is not a malignant, infectious one, and the tumors are of a benign nature. They have been most frequently met with upon the spinal nerves at the surface of the body, but they may also be seated upon the cranial nerves, in the nerve roots, in the cranial and spinal cavities, and, finally, upon the great sympathetic nerves. Multiple neuromata are frequently congenital and hereditary, as I have been able to determine in several members of one and the same family.

The structure of multiple neuromata varies: These tumors are most often fibromata, and in the case of a patient under my observation, whose case will be again referred to, this was the nature of the growths.

Symptoms of Multiple Neuromata.—Three stages should be recognized in the course of these lesions. In the *first*, which may be of very long duration if the tumors are congenital, the disease is unnoticed; it does not manifest its presence by any symptom, though sometimes tinglings and pains precede the appearance of the tumors. In the *second* stage, the tumors appear, and may be accompanied by disturbances of sensibility and motility. In the *third* stage, the general condition becomes worse, and death may supervene.

Symptoms of Second Stage, or Stage of Tumors.—Tumors are seen in different parts of the body, upon the course of the nerve branches; they present a

variable bulk, and are not generally the seat of any pain. In other cases there occur disturbances of sensibility and motility. These have been summarized, so to speak, in a case under my care for the past two years.

A man, twenty-one years old, entered the Laennec Hospital during my service of June, 1880. At the age of nine years it had been noticed that he had upon the upper part of the right thigh a tumor of the size of an egg, and soon other very small tumors were seen upon the neck and thighs. In 1879, he had, without any known cause, an orchitis, which terminated in atrophy of the testicle. A few months after, the tumor of the thigh having increased, it was removed. It was considered to be of a fibro-plastic nature; but afterwards was recognized as having for its origin a nerve-tumor like those which existed in great number upon other parts of the body. The wound caused by the operation healed, but the disturbance of sensibility and motility remained. It was at this period that I saw the patient. Fusiform tumors in great number were found along the course of the nerves, tumors which were painless and mobile, and which occupied the thighs, the abdominal wall, the upper extremities, the neck, the occipital nerves, the face at the mental foramen, etc. Pressure upon these tumors produced a sensation of numbness and tingling.

Similar tumors very probably existed upon the deep branches and in the spinal cord. Indeed the patient presented, as has been said, disturbances of sensibility and motility, a sensation of numbness and tingling in both upper and lower extremities. Muscular paresis was also observed, and at the same time very painful cramps and contractures which maintained the limbs in a state of flexion. There was also atrophy of the muscles. These symptoms continued more than three months, and then gradually disappeared under the influence of bromide of potassium, in the dose of 5 grammes (gr. lxxv.) daily. The patient was able to work for a year, but was then obliged to re-enter the hospital on account of the cramps and contracture; some of the neuromata had acquired the size of small almonds, and had become painful; I removed them, and administered the bromide of potassium. All the symptoms again disappeared, and since that time the patient has pursued quite a laborious occupation in the hospital.

On the other hand, I have observed a patient who has had for a long time small elongated tumors of the size of a pea along the course of the nerves in different regions, without these determining any symptom; they have also preserved their small size.

Symptoms of Third Stage.—We have seen that, in certain cases, multiple neuromata are not accompanied by any symptoms, and do not affect the health; in others, on the contrary, this is seriously injured, and death may supervene in consequence of the intensity of the pains and of the disturbances of nutrition. Poincot designates this period as that of *wasting*.

There is another complication which has been noted in several cases, including my own; one of the neuromata undergoes a rapid increase, and may become a fibro-plastic or sarcomatous tumor. Virchow has reported a case in which neuromata of the upper extremity successively experienced this transformation, ultimately necessitating amputation of the arm. It must be noted that in several cases, as in that of my patient, the principal tumor has been seated at the upper part of the thigh.

CONNECTION OF THE TUMOR WITH THE NERVE.—The connections of the tumor with the nerve upon which it is seated are variable, and may be determined by the point of origin of the neoplasm, according to whether it arises in the neurilemma, in the perineurium, or in the intra-fascicular connective-tissue bundles.

Virchow says that he has observed independent, hyperplastic neuromata without connection with the neighboring nerves; in a case of Lebourcq's, the tumor was connected to the nerve by a pedicle; in other cases it has simply touched the nerve.

The tumor is often developed in the thickness of the nerve, of which it

seems to be a regular dilatation, more or less fusiform; the nerve fibres have then an arrangement which varies according to the particular case (Lebert, Michon, Verneuil); they may be separated and pushed over to the periphery of the tumor for which they form an envelope (Velpeau, Lanelongue). There are cases in which the tumor seems to be spitted upon the nerve; sometimes the nerve is found situated in a groove upon the tumor, an arrangement which permits the nerve-trunk to be readily dissected out, as was done by Duncan and Velpeau; sometimes the nerve is lost in the midst of the morbid tissue, as in a fibroma of the median nerve reported by Wietfeldt; sometimes, finally, it is spread out on the deep surface of the tumor (Foucault).

It was upon these relations of the tumor to the nerve, that Lebert based his classification of neuromata into (1) the peripheral neuroma; (2) the interfibrillar or central neuroma; (3) the lateral neuroma; and (4) the diagonal neuroma, in which the nerve traverses the tumor, no longer following its long axis, as in the central neuroma, but pursuing a diagonal course.

What is the state of the nerve below the tumor? Does it undergo the Wallerian degeneration? The latter probably exists when the continuity of the nerve has been destroyed, as in Wietfeldt's case. But in many instances there has been found no alteration of the nerve beyond the tumor (Vulpian); this was the condition in Trélat's case, and in my own case of multiple neuromata. Houel has noticed a lengthening of nerve-trunks which have several tumors upon their course, causing them to pursue a serpentine track, analogous to that of varicose veins.

ETIOLOGY OF NEUROMATA IN GENERAL.—Our knowledge of the etiology of neuromata and of nerve-tumors, is very limited. According to the researches of Poincot, neuromata, including under this name all tumors of nerves, are more frequent in men than in women. They are met with at all ages; they may be congenital or may occur in old age; they are most frequent in men between the ages of twenty and fifty years, and in women between the ages of ten and forty years (Poincot).

The cause of the development of these tumors is most often unknown, except in the case of the so-called traumatic neuromata (Smith); an inflammation of the adjoining tissues may also cause the production of a tumor. Fuhrer, cited by Virchow, saw, upon a limb amputated for caries of the wrist, a neuroma of the median nerve, seated at the level of the diseased part.

An increase in the size of the nerves has been noted in elephantiasis, in myxœdema (Hanrot), and in leprosy. Brown-Séquard insists upon the constant presence, in leprosy subjects, of a tumor of the ulnar nerve, but Foucault did not find it in eight patients whom he examined.

It is also admitted that syphilitic gummata may form upon nerve-trunks. Leboucq reports a case of neuroma which disappeared under treatment with iodide of potassium.

Virchow divides neuromata according to their origin into *congenital*, *traumatic*, and *spontaneous* neuromata.

SYMPTOMS OF NERVE-TUMORS.—Frequently the tumor is developed slowly without giving any manifestations of its presence, and is only discovered when it has reached a certain size; in other cases its appearance is preceded by numbness or by pain. The tumor is situated over the course of a nerve, and is more or less readily detected according to the seat of the nerve which it occupies; it has been mentioned that the superficial nerves are more often affected than others. The tumor is generally oblong, ovoid, rounded, smooth, resisting, and with a certain elasticity. Its size varies very much, and it

may attain considerable dimensions—the size of the fist, for example—but then presents some transformations; it no longer exhibits the same regular shape, nor a uniform consistence. The tumor is movable in a plane perpendicular to the direction of the nerve, without change of the color of the skin.

Pressure upon the tumor, which is sometimes painless, quite often determines numbness, tingling, and pains which are at times violent. Pressure exerted upon the nerve above the neuroma permits the latter to be examined without the patient experiencing pain. Spontaneous pain appears when the tumor has acquired a certain size; it varies in its character, duration, and intensity, and occurs in paroxysms under the influence of atmospheric changes, the heat of the bed, movements, etc.

Motility may be affected in the territory of the diseased nerve; these are muscular twitchings, cramps, and contraction. Occasionally all the muscles of a limb are affected at the same time. These painful paroxysms have been followed by general convulsions, and in one case the paroxysm presented the characters of angina pectoris (Cayzengues).

Generally, neuromata do not cause nutritive lesions of the limb; we have seen above that there is no degeneration of the nerve beyond the tumor.

DIAGNOSIS.—The recognition of *isolated neuromata* may present some difficulties; they are generally fusiform, and seated upon the course of a nerve; quite often they are accompanied with pain, and compression of the nerve above the tumor causes the pain to disappear. A neuroma might be readily confounded with a *partial peri-neuritis* with inflammatory neoplasia; but this is seldom met with. A *fibrous tumor* is indolent, and does not occupy exactly the course of a nerve; a neuroma could hardly be confounded with an *aneurism*.

If the tumor be deeply placed, the diagnosis may be impossible; such was Bérard's case, in which a neuroma of the phrenic nerve gave rise to the symptoms of angina pectoris.

After having recognized that the tumor is seated upon a nerve, it is necessary to inquire what is its nature, but this is most often impossible. It will be seen hereafter how, in the majority of cases, a neuroma may be distinguished from a *painful subcutaneous tubercle*.

Plexiform neuromata are seen at birth, or during early life; they have a peculiar appearance, and can be recognized without much difficulty. The same may be said as regards the diagnosis of *multiple neuromata*. They are to be distinguished from the small, subcutaneous *fibromata* which are met with in rheumatic patients, and which are scattered at random, or collected around the articulations. *Subcutaneous lipomata* are occasionally multiple, small in size, and symmetrical; but the shape of the tumor is not regular, it often adheres to the deep surface of the skin, and does not follow the course of the nerves; it is always indolent. The diagnosis from the *subcutaneous nodules caused by the presence of the cysticercus* may be more difficult; sometimes there are found upon a limb several small, oblong, movable, indolent, subcutaneous tumors, which might be mistaken for multiple neuromata of a nerve or of a region. In case of doubt, it would be proper to remove one of the tumors, when the presence or absence of a cysticercus would decide the diagnosis.

Finally, multiple neuromata must not be confounded with the tumors of *disseminated cancer* of the skin.

PROGNOSIS.—The *prognosis* of neuromata is very variable, as has been seen. Sometimes it is favorable; in other cases it is grave on account of the inten-

sity of the pains which they determine, or of the modifications which one of the tumors may undergo. In multiple neuromata, the prognosis is generally serious.

TREATMENT OF NEUROMATA.—This may be divided into the medical and the surgical treatment:—

(1) *Medical Treatment.*—This has but little effect upon tumors of nerves, except in the case of syphilitic gunmata. But it is often very efficacious in relieving the symptoms of neuromata, especially the pain. This often depends upon the general state of the patient, whether arthritic, malarial, syphilitic, or neurotic, and an appropriate treatment may then cause it to disappear. Ice has been employed as a local application, and antiphlogistics have been used; in the case of my patient with multiple neuromata, I obtained the disappearance of all the symptoms, except the presence of the tumors themselves, by giving large doses of bromide of potassium.

(2) *Surgical Treatment.*—This is indicated when medical treatment has failed, and is directed against large, fibrous or sarcomatous tumors of nerves, or against those which are the seat of sharp, insupportable pain.

The importance of the nerve is not a contra-indication, particularly as in a certain number of cases the operation has been followed by a re-establishment, more or less complete, of the functions; the existence of several tumors is not always a contra-indication. Sometimes, in cases of multiple neuroma, one, two, or three tumors are painful, while the others remain indolent; the painful tumors should then be removed. In the case of the patient of whom I have already spoken, I have thus performed several operations, and at the present time he enjoys perfect health.

Operations employed for Nerve-Tumors.—The *cauterization* of nerves and nerve-tumors, practised in former times, and recommended anew by Legrand, in 1858, is almost never employed at the present time. Recourse may be had to the following procedures:—

(1) *Enucleation.*—Virchow divided neuromata into *complete* and *partial* neuromata, according to whether all or part of the nerve-fibres were implicated in the neuromatous process. In the partial neuromata, the tumor, occupying only a portion of the nerve-trunk, may be removed by enucleation without injuring the healthy part of the nerve. For this purpose, the tumor having been exposed, its connections with the nerve are examined, then the neurilemma which covers the tumor is incised, and an attempt is made to dissect out the growth from the nerve, since if even a few of the nerve-fasciculi are uninvolved, it is desirable to preserve them, in order to facilitate the regeneration of the nerve and the re-establishment of its functions (Roux, Velpeau, Bickersteth, Letiévand, Lanelongue). If the tumor has a groove excavated in it, which incloses the nerve, the operation is easy; it is the same if the case is one of lateral or pedunculated tumor (Voillemier, Leboucq). If it is possible, there should be left a portion of the nerve, when the tumor is non-malignant; but if it is a sarcomatous tumor, for example, the nerve should be resected at a higher point.

(2) *Extirpation.*—This is the operation most frequently adopted; all the diseased portion of the nerve is removed, care being taken to make the first section of the nerve above the neuroma, in order to diminish the pain and reflex phenomena. After the operation, an attempt is made to approximate the ends of the nerve by position or by suture (Nélaton, Notta). Extirpation is also recommended in cases of plexiform neuroma.

(3) *Neurotomy.*—When the nerve is so deeply situated that it cannot be reached, or that the operation presents too many dangers—or even if several

tumors are seated upon the same nerve—section of the nerve above the tumor has been practised in several cases, in order to cause the disappearance of the pain. Resection of a portion of the nerve-trunk has also been done in similar cases, instead of a simple neurotomy. The same practice has been advised in cases of secondary cancer of painful and inaccessible nerves.

(4) *Amputation*.—Finally, amputation has been practised in cases of painful multiple neuromata of one and the same region (Smith). In cases of this kind, Arloing and Tripier prefer multiple and associated sections of the nerves, made at the root of the limb. In a case cited by Virchow, amputation of the arm was resorted to for multiple nerve-tumors which were thought to be of a fibro-plastic nature, but which, says Virchow, were nothing but neuromata.

PAINFUL SUBCUTANEOUS TUBERCLE.—Under the name of painful subcutaneous tubercle, there has been described since the time of William Wood, who made the first serious study of it,¹ an affection characterized by the existence of a small subcutaneous tumor, of which the principal characteristic is to become extremely painful under the influence of different causes. This affection has further been designated under the names of *irritable tumor*, *gunlion*, *painful subcutaneous fibroma*, and *painful neuroma* (Virchow).

The nature even of the tumor which causes the painful symptoms is variable, as we shall see, and it may be asked whether the painful subcutaneous tubercle should be considered and described as a distinct disease, or whether the symptoms which characterize it are not rather accidental phenomena, which may occur to complicate the evolution of different tumors more or less immediately subcutaneous, and which may appear under the influence of causes yet unknown. We shall limit ourselves to proposing this question, the solution of which demands special researches that do not properly belong to an article of this kind, and shall then pass immediately to the clinical study of this affection, and to an exposition of the different views which have been set forth as to its pathological anatomy and nature.

Etiology.—Painful subcutaneous tubercle is particularly observed during adult age, from thirty to fifty years. All authors remark its greater frequency in women, and, in certain cases, the coincidence of the beginning of the pains or exacerbations with the menstrual period, with pregnancy, or with the menopause—all circumstances which increase the nervous excitability—so that Broca was able to say that it was the patient who was irritable rather than the tumor. As to traumatism, frequently invoked by patients as in the case of all tumors, its influence is doubtful; perhaps, however, it contributes to the development of the painful symptoms by irritating a tumor which has been previously indolent.

As a local cause, the seat of the small tumor plays, perhaps, an important part; indeed, we shall see in studying the pathological anatomy of this affection, that it is most frequently met with in regions where the skin is in direct relation with the bones and articulations.

Symptoms.—Pain and tumor, these are the two symptoms of this affection; but they are not ordinarily developed at the same time. Sometimes it is the pain which shows itself before any tumor is appreciable; more often the tumor appears first, and only becomes painful after a longer or shorter period, either in consequence of a traumatism, or spontaneously. The disease once constituted, there is observed a small tumor, which seldom exceeds.

¹ Edinburgh Medical and Surgical Journal, 1812.

the size of a pea or bean, subcutaneous, or forming more or less a part of the deep surface of the derm, and consequently more or less movable, hard, smooth, round, and accompanied sometimes with modifications of the skin which will be again referred to. The slightest handling of this tumor provokes an explosion of painful, neuralgia-like paroxysms, accompanied with centrifugal or even centripetal irradiations, and having an intensity and variable duration according to the particular case. Strong pressure may, on the contrary, not determine painful paroxysms. In the interval of these paroxysms all the painful phenomena generally disappear.

Pain is not only provoked by the examination of the tumor, and by the contact and friction of the clothes, but it is further determined by movements of the part, or by muscular contraction, and supervenes even, especially when the affection has lasted for a certain time, from inappreciable causes.

According to Bouchage, who reports in his thesis a minutely analyzed case of painful subcutaneous tubercle, there may be distinguished two varieties of pain, so to speak, which are due, the one to the general sensibility, which is increased at the seat of the tumor, the other to the special connections which the tumor has contracted with the smooth fibres of the deep surface of the derm and the surrounding small nerve-filaments. After a sudden blow upon the tumor, for example, the first variety shows itself by an immediate and temporary pain, and the second by the characteristic painful paroxysm which is delayed a few moments after the excitation. It is upon this kind of incubation of the painful paroxysm, that the author has based a pathogenic theory which will be hereafter explained.

The paroxysm presents great variety according to the patient: sometimes it is a bearable pain, which scarcely disturbs the patient a few minutes from his occupation; sometimes it is a more acute suffering, which may last several hours; sometimes, finally, the paroxysm is sufficiently violent to provoke syncope, or to be accompanied by epileptiform convulsions.

In a certain number of cases there are noted, at the moment of the paroxysm, changes, of which some affect the tumor itself, and some the skin which covers it. As regards the tumor, there has been noticed a kind of turgescence, or an increase in consistence, and a greater adherence to the skin (Bouchage). In regard to the skin, it is congested and reddened, according to some authors, during the paroxysm, although in Bouchage's case paleness replaced at this moment the violet color which it had in the intervals between the pains.

Course.—We have seen that the tumor in most cases exists before the appearance of the painful paroxysms. This period of painlessness may be quite long, and may last even for several years. The evolution of the tumor is always extremely slow, and we know that its size does not exceed that of a pea or bean; at first subcutaneous, it ends most frequently by becoming adherent to the skin, which then sometimes assumes a violet color. The painful paroxysms generally follow a slowly progressive course, and have no tendency to a spontaneous recovery; nevertheless, in exceptional cases they have been found to become milder, and to disappear without treatment, at the same time as the tumor. In this connection Windsor's case may be cited, in which a painful tumor of the forearm, appearing after a bleeding, was found to be formed of small, hard granules inclosed in a cystic membrane. The patient was fifty-nine years old, and Bouchage regards the case as an example of cretaceous transformation and segmentation of a fibrous tumor. The pain always yields to the ablation of the tumor, but in certain cases may continue for a time after the operation, and only disappear gradually. Finally, although these tumors do not, properly speaking, recur, yet several may require opera-

tion in the same individual, though it is exceptional to observe more than one at a time.

This affection has no direct influence upon the general health, but it is scarcely necessary to say, that the existence of violent, frequent, and prolonged paroxysms necessarily affects nutrition, and causes a more or less rapid enfeeblement, which, again, facilitates the return of the painful crises.

Pathological Anatomy.—It is the pathologico-anatomical study of painful subcutaneous tubercle, which may give rise to doubts in regard to its existence as a distinct disease; in opposition to analogous clinical features, indeed, very different results are obtained by microscopical examination; fibromata, myomata, angiomas, fibro-myxomata, true neuromata, chondromata, lipomata, even carcinomata, have, during life, caused symptoms of the affection under consideration. Fibromata, however, according to most authors, constitute the majority of these tumors.

We have seen that painful subcutaneous tumors are generally single; their seat is usually in the subcutaneous cellular tissue, especially at the points where the skin is in direct relation with the bones and articulations; the regions where they have been observed, in order of frequency, are the legs, face, back, fingers, mammae, and scrotum. But their origin is not always so superficial; in Fock's case, the tumor was implanted upon the periosteum of the tibia, and it was intra-articular in two cases of Busch's. These tumors never reach a large size; they are ordinarily not larger than beans. We have seen that they usually become adherent to the skin after a certain time. Their shape, generally rounded, and their external appearance, vary very much with the nature of the tumor. But these differences are only distinctly appreciable when the tumor is in our hands. When the growth is a fibroma or myoma, the surface is smooth and pearly, the consistence solid and elastic, while the appearance of the section recalls that of fibrous tumors of the uterus. The histological examination shows fibrous elements interspersed with nuclei and a few fusiform, fibro-plastic bodies, or smooth muscular fibres, without any trace of nerve-filaments either in the limbs, upon the surface, or in the interior (Follin, Lebert). The majority of these tumors are, as it were, encysted by a fibro-cellular envelope.

But while admitting the existence of these painful fibromata, it cannot be denied that true neuromata may occasion the same symptoms (Virchow). The tumor may present the characters of the fasciculated neuroma (Labbé and Legros), of a fibro-myxoma inclosing in the midst of its stroma myelinic nerve-fibres (Chandelux), or of a telangiectasic neuroma (Schulz); or it may even recall the structure of a hypertrophied Pacinian corpuscle (Axmann).

Other cutaneous or subcutaneous tumors have also occasioned the symptoms of painful subcutaneous tubercle; I need only cite the case of carcinoma of the skin reported by Dupuytren in his lectures, and two very interesting cases of Busch, where the pain was determined by very small, true, intra-articular chondromata arising some distance from the articular cartilage of the femur in one case, and from one of the phalanges of the thumb in the other. Histological examination showed that these tumors were formed of pure hyaline cartilage, completely deprived of nerves.

Pathogenesis and Nature.—It is seen, in short, that the relation of lesion to symptom is not yet well established in regard to this affection, and that it cannot, without forcing the facts, be admitted, with Follin, that the tumor of true painful subcutaneous tubercle is always a fibroma, or positively distinguishable from neuroma, of which it may present the structure. The opinion of Broca is less positive; this author thinks that every subcutaneous tumor

may become irritable, but that the fibromata are so disposed more than all others, on account of their hardness, which irritates the small nervous filaments in their proximity. It would appear that in the actual state of science it is impossible to be more definite without entering the field of hypothesis. This can only be done after having discovered the anatomical reason why one subcutaneous tumor is painful and another is not.

As to the mechanism itself of the production of the painful paroxysm, hypotheses only have been advanced upon the subject. Without speaking of exceptional cases, in which true neuromata have existed, we have seen that the tumor does not present any trace of nerve-elements; the cause of the pain must then be sought for in a neighboring compression or irritation, of which, unfortunately, there is no anatomical proof; there cannot, obviously, be any invasion of the nerve-filaments by the tumor, since this has been in all cases, except Dupuytren's, a benign tumor, which is consecutively developed by simply pushing away the neighboring parts. The general condition of the patient must also be carefully considered. The ingenious hypothesis of Bou-chage upon the pathogenesis of the painful paroxysms must also be mentioned. Sustaining himself upon the fact that, in the case which he studied, the adherence of the tumor to the integument was stronger at the moment of the paroxysms, and upon the change in color of the skin, which then became pale in place of remaining violet; and relying also upon the existence of a short period of "incubation" of the paroxysm, this author attributes it to the contraction of the smooth muscular fibres of the deep surface of the derm—a contraction slow in appearing and slow in disappearing, like the paroxysm itself, and acting by pressing the tumor against the nameless nerve-filaments which surround it.

Diagnosis.—Careful examination of the painful region will readily enable the small tumor to be discovered, and will prevent this affection from being confounded with *neuralgia*. Most frequently, however, the patient already knows of the tumor, and points it out himself. This differential diagnosis is evidently impossible in the exceptional cases in which pain precedes the tumor, and can only be made upon the appearance of the latter. At most, the possibility of the existence of this affection might be foreseen from the seat of pain being in one of the regions which we have pointed out, and from the absence of all other causes capable of explaining it. We have seen that the painful subcutaneous tubercle may present the structure of a *neuroma*, and we cannot therefore follow Follin in discussing the diagnosis of these two affections, which may be blended; it is evident that painful subcutaneous tubercle would not be thought of in cases of neuromata presenting themselves with their ordinary course in the form of multiple tumors along the known track of a nerve, nearly painless, and with relatively rapid and considerable development; let us add that neuromata are very much more frequent in men than in women, herein differing from the affection which we are considering. But when a painful subcutaneous tubercle is recognized, it cannot be affirmed that it is not constituted by a small, isolated neuroma; indeed, most frequently the nature of the tumor under observation is only known after removal by operation, unless the case is one of carcinoma of the skin, for example, the ulceration and course of which do not leave any doubt.

Prognosis.—The prognosis is dependent upon the nature of the tumor; that is to say, it is generally favorable, in the sense that there is no fear either of generalization or of direct alteration of the general health. But, on the other hand, it has been seen that a spontaneous disappearance of the pains is not to be counted upon, and that, on the contrary, they generally continue

increasing; it is then necessary to interfere if they are so severe as to prevent the patient from continuing his occupation, and still more, if their duration and frequency threaten to impede nutrition. Moreover, weakness facilitating the return of the paroxysms, the situation may, indeed, become grave, and may terminate in a true cachexia (irritable weakness).

Treatment.—The therapeutic indications are, perhaps, the only points well established in the history of painful subcutaneous tubercle. All authors agree in recognizing that *narcotics* are powerless to cause recovery, and constitute only a palliative medication of a duration necessarily limited, on account of the digestive disturbances caused by their prolonged employment. If the pains are not intense, the paroxysms may be rendered less frequent by the patient wearing a *protective covering*, as recommended by the authors of the *Compendium de Chirurgie*, but the only curative treatment is ablation of the tumor, which is ordinarily followed by complete recovery. In certain cases, however, the pains have persisted after the operation, and have only gradually disappeared. Caustics should not be used in this operation, but the little tumor should be removed with cutting instruments; in no case has the cicatrix become the starting-point of new pains.

TETANUS.

DEFINITION.—Tetanus is an affection characterized by a permanent and painful contraction of the majority of the voluntary muscles, which habitually begins in the muscles of the jaws and of the neck, gradually extends to the other muscles, and is accompanied by convulsive paroxysms.

Tetanus may be *traumatic* or *spontaneous* (tetanus *a frigore*, rheumatic tetanus); *chronic*, *acute*, or *subacute*; *continuous*, *discontinuous*, or *intermittent*; finally, it may affect different muscular groups. The name *trismus* is given to the contraction of the elevators of the lower jaw; *opisthotonos* to that of the extensors of the neck, trunk, and inferior extremities (this is the most frequent variety); *emprostotonos* to that of the flexors; and finally, *pleurothotonos* to that form which is constituted by the contraction of the muscles which draw the vertebral column laterally; this last variety is very rare. Lastly, tetanus is called *tonic* when the spasm affects all the voluntary muscles (Föllin).

ETIOLOGY OF TETANUS.—All traumatisms in all conditions, with or without wound, may be complicated by tetanus. It must, however, be recognized, as it is by all authors, that it seems to supervene most frequently after contused wounds of the extremities, feet or hands, of the scalp, and, generally, of regions where the Pacinian corpuscles abound (Gubler). The seat of the wound may then have a certain influence upon the production of tetanus, but the gravity and extent of the wound have none. Tetanus has been seen to occur after subcutaneous injections of sulphate of quinine, or dilatation of the neck of the uterus with a sponge tent, as well as after the most grave traumatisms. In certain cases, however, a sufficient cause is found in the wound itself, to explain the production of the malady; lesions of the nerves, a foreign body inclosed in a nerve, painful granulations, or a cicatrix including a nerve extremity. Most frequently it is not in the wound itself that the principal cause of tetanus is to be sought for, but in the state of the patient and in the conditions by which he is surrounded. Age, sex, alcoholism, and even the puerperal state, which is invoked by some authors, appear to be without influence; it is not the same as regards *malaria*, which seems to predispose to

tetanus. (Intermittent fever of a tetanic form has even been described.) *Race* especially seems to play an important part, tetanus being more frequent and more grave among negroes, independently of climatic influences. Finally, *inheritance* was invoked in a case of Metzger's. But the most important condition is *individual predisposition*, a vague cause which we are forced to admit in view of the disproportion which exists between the number of instances of tetanus, and that of cases which unite the conditions believed to be sufficient to provoke this affection. When we shall have mentioned the condition of over-work, and that of moral depression, which have been sometimes invoked with probability, it will only remain for us to speak of the *surrounding conditions* which play a very important part, and the most important of which is cold. *Cold*, moist cold, and especially sudden variations of temperature—which explain the frequency of tetanus in certain climates with high temperature, Cayenne for example—are occasional causes, admitted by all authors, which may be sufficient (tetanus *a frigore*), but which are not met with in all cases. Nothing is more convincing than the case cited by Mirbeck, of that American infant who died of tetanus four days after having received, full upon its chest, a glass of iced water, being in a sweat. It is through the influence of joint causes, cold and moral depression, upon the wounded who remain upon a battle field (the battle of Bautzen, for example), that the epidemics of tetanus which are sometimes observed are generally explained. Some authors admit the possibility of *contagion*, of *poisoning*, as in surgical septicæmia. Betoli reports the case of slaves who died of tetanus after having eaten the flesh of a bull which had perished from this affection. This latter mode of transmission is admitted, it seems, in certain regions of America.

PATHOLOGICAL ANATOMY.—The lesions characteristic of tetanus have been successively sought for in the spinal cord and its envelopes, in the brain, in the nerves near the wound, and finally, in the muscles. We shall briefly pass in review the principal results of the autopsies which have been made, and shall see what conclusions may thence be derived.

The *brain* is generally healthy; there have been described, congestion of the meninges, convolutions, pons, tuberculæ quadrigeminæ, and corpora striata, colloid degeneration of a part of the cerebellum, and, in one case, tumor of the cerebellum (Jackson); upon the whole, nothing constant. The *meninges* of the *medulla oblongata*, which are sometimes found irritated or even inflamed, are more often normal.

It is upon the *spinal cord* that investigations have been especially concentrated, and it is also here that lesions have been most frequently found. The facts which have been observed may be arranged in three classes. In the first are placed the negative cases, where the spinal cord does not present any change after death, although the histological examination has been made by observers of unquestionable authority; in the second class are the cases where only a simple hyperæmia has been established, especially marked around the bulbar nuclei of the cranial nerves, and around the canal of the ependyma and of the roots of the nerves going to the injured region. Finally, the third class includes the positive lesions: nuclear proliferation in the reticular substance, and a return of the cellular elements to the embryonal state, whether by modification of the protoplasm or by degeneration of the cells; plates of granular degeneration of Lockhart Clarke, which are, according to Michaud, foci of perivascular exudation; colloid degeneration, etc.; in short, *myelitis*, more or less advanced, occupying especially the regions of the spinal cord in which congestion has been noted in other cases (hyperacute central myelitis of Charcot and Michaud).

As peripheral lesions there have been found a certain number of times a redness of the neurilemma of the *nerves* which correspond to the wound, and even a more or less extended *ascending neuritis*, perhaps most frequent when the tetanus begins at the wounded part; but more often the nerves are normal, like the *muscles*, which have also sometimes presented a beginning of interfascicular sclerosis or of waxy degeneration, without speaking of the effusions of blood and ruptures due to their excessive contractions. We must mention finally the cases where the cause of the tetanus has been evidently a *foreign body* remaining in the wound, or inclosed in the nerve itself, as in the classical case of Dupuytren's where the knot of a whip-lash was found in the ulnar nerve. Lastly, inflammatory lesions have also been noted in the great sympathetic.

To recapitulate: The most frequent lesions are those of the spinal cord, but even these may be absent. It must, then, be admitted that the anatomical condition of tetanus is a simple irritation of the nerve-elements, perhaps a slight congestion, which leaves no traces after death, but which may terminate, if it is prolonged, in a permanent hyperæmia, a consequence and not a cause of the exaggerated activity of the nerve-cells (Vulpian); with still more reason should the deeper lesions that we have described be considered as secondary.

NATURE AND PATHOGENESIS; PATHOLOGICAL PHYSIOLOGY.—What is the nature of tetanus? Without speaking of the theory of Stutz and Martin de Pedro, who located the disease in the muscular apparatus—a theory which would seem very difficult to maintain—all authors agree in considering it a pathological reflex condition, with exaggeration of the activity of the spinal cord. But when these vague terms are set aside, the agreement is soon broken, and there are almost as many explanations as authors in regard to the nature of primary peripheral irritation, and the path by which it is transmitted to the spinal cord. The opinions which have been put forth may be divided into two classes, one admitting an alteration of the blood which directly determines the exaggerated activity of the cord (humoral theory), while the other finds in the nerve-trunks the agent which receives and conducts the initial irritation (nervous theory). We shall successively set forth these two theories.

(1) *Humoral Theory*.—The alteration of the blood which is considered the determining cause of tetanus, has been compared to that which is produced by poisoning with strychnia, or to that which produces rheumatism, the determination of the lesions upon the spinal cord, rather than upon the articulations or other viscera, belonging therefore to an individual predisposition. Others, seeking for the origin of the alteration of the blood, have made it the result of a partial poisoning from the wound, or of an autochthonous septicæmia determined by the sudden suppression of the functions of the skin, and the passage into the blood of its excretory products; finally, Trevisanello supposes it to be produced by a specific element, making tetanus an infectious disease—an opinion against which may be advanced the negative results of the inoculations hitherto practised. Independently of the mechanism of the alteration of the blood, there have been invoked in favor of the humoral theory, the elevation of temperature analogous to that of septic diseases, but not constant; the epidemic character which tetanus may assume, and which may result from the simultaneous action of the same causes; and, finally, the existence of an intermittent fever of tetanic form. At all events, the few recoveries unquestionably due to neurotomy and to the removal of cicatricial constriction by incision, show that this theory is not applicable to all cases.

(2) *Nervous Theory*.—The primary irritation has been located in the muscles or in the extremities of the nerves themselves. Forbes explains it by an excess in the production of creatin and lactic acid in consequence of an exaggerated muscular degeneration, which is itself dependent upon an excessive nervous activity which he leaves unexplained. The advocates of the theory of the primary irritation of the extremities of the nerves, admit that this may be produced in the wound in a variable and often undetermined manner, and they have to sustain them a certain number of cases where this cause is unquestionable (foreign bodies, defective cicatrices), and where the success of neurotomy, of amputation, or of incision of a cicatrix, has distinctly demonstrated its action.

Whatever may be, however, the theory that is adopted, in view of the great number of wounds and causes of chilling, and of the rarity of tetanus, we are obliged to consider the appearance of this affection as dependent upon an individual predisposition, impossible to ascertain or even to suspect beforehand.

The irritation, once transmitted to the spinal cord by the nerves or the vessels, determines there an increase of reflex power, which betrays itself only secondarily by morphological lesions appreciable by our means of exploration. The mechanism of this increase of reflex power of the spinal cord is yet disputed, some regarding it simply as increased functional activity, while by others it is thought due to paralysis of the moderator centres of reflex action, of which Vulpian contests the existence, or, finally, as believed by Ringer and Murrell, to a diminution of the *resistance* of the spinal cord, this word designating a force which tends to locate peripheral stimuli in a given segment of the cord, and to regulate the nervous discharge.

This excitation of the spinal cord is manifested clinically by two sets of symptoms, the one constant—the more or less generalized muscular contraction—and the other inconstant and variable, the increased temperature, as to the pathogenesis of which authors have expressed different opinions. Its production has been attributed to asphyxia, which it often precedes for some time—to the presence of a complication which is not met with in every case where an elevation of temperature is observed—and to a septic change in the blood, in favor of which its existence is an argument. A view more attractive at first sight, is that maintained by Muron, which explains the high temperatures of tetanus by the heat liberated by the muscles in tonic contraction; but, apart from the fact that a generalized tetanus may not be accompanied by an elevation of temperature, the highest temperatures are not always coincident with the paroxysms in the same patient, and are not proportional in different patients to the intensity and to the generalization of the muscular contractions. Finally, this hypothesis does not explain the elevation that is sometimes seen after death, and which may, according to Wunderlich and Leyden, exceed 2.5° C. (4.5° Fahr.).

There remains a view which seems acceptable, and which makes the increase of temperature depend upon the exaggerated spinal activity itself, which produces it by accelerating beyond measure the interstitial combustions; these may in certain cases maintain the impulse which is given to them, so to speak, and may continue to elevate the temperature some time after death. A very useful element of this investigation would be a thorough knowledge of the modifications of the blood and urine in tetanic patients, of which unfortunately very little is yet known.

To summarize: tetanus should be considered as a pathological reflex state, having for its point of origin a peripheral irritation of undetermined nature; for its actual condition, an exaggerated functional activity of the spinal

centres without any special lesion; and for its effect, muscular contractions with or without elevation of temperature. [See page 275.]

SYMPTOMS AND COURSE.—Tetanus reveals itself by two orders of symptoms of very different importance—one constant and necessary, *muscular contraction*, and the other very variable, and sometimes entirely absent, *elevation of temperature*. Let us first study these symptoms by themselves, with the changes of pulse, blood, and urine, and we shall afterwards see how they are combined and modified, so as to constitute the different varieties of the disease.

The *muscular contraction* characteristic of tetanus, is a *permanent, tonic convulsion, with paroxysms*; but it does not, at the first onset, present itself in this form. Each group of muscles contracts at first in an intermittent manner, at the moment of the general paroxysms only, and is completely relaxed in the interval; then the contraction becomes continuous, with an increase at the moment of the crises, and it is under this form that it persists the longest; finally, in exceptionally grave cases, the tonic contraction may be so energetic that the crises do not sensibly influence it. When recovery is about to occur, the permanent contractions again alternate with complete remissions before disappearing, and, finally, show themselves only with voluntary movements. At this period of decline the convulsions are less easily provoked by external excitation, and do not continue as long as during the periods of the disease's increase and height.

The *temperature* may remain normal, or nearly so, even in the most acute cases; when it is elevated it has no defined cycle, and may present all variations, without necessary relation to the gravity of the disease and the intensity or generalization of the muscular contractions—without, in fine, the maxima constantly corresponding to the paroxysms; the evening increase is not observed as in most acute diseases. These restrictions made, it must be said that, in very acute cases, the most frequent course of the temperature is the following: It is at the outset 39° C. (102.2° Fahr.) in the axilla, and the increase continues, with or without oscillations, until it exceptionally reaches (Wunderlich), at the moment of death, 43° , or 44.75° C. (109.4° or 112.5° Fahr.); the temperature may sometimes be further elevated after death, and the same observer has seen it reach 45.3° C. (113.5° Fahr.) in these conditions. In other cases, on the contrary, death is preceded by a lowering of the temperature.

The *modifications of the pulse* seem to correspond more exactly with the course of the disease and with the paroxysms; from 80 to 120 in mild cases, the number of pulsations may be increased to 150 and 160 in the grave cases; according to other authors, however, the curve of the pulse is pretty closely parallel to that of the temperature.

Finally, in regard to the *modifications of the urine and of the blood*, in the writings of the few authors who have studied these, there are found only contradictory results; the amount of urea, for example, is increased according to some, and diminished according to others. The analysis of these liquids in tetanic patients would furnish, however, an important foundation for the study of the pathological physiology of the disease.

General Type of Tetanic Symptoms.—In the first fifteen days which follow the injury, without any precursory sign on the part of the wound—such as dryness, bad appearance, or arrest of cicatrization, to which formerly were attributed some importance—the patient is seized with a slight trismus, which still permits a little separation of the jaws, but which is increased if we attempt to overcome it, and which is accompanied by a particular aspect of the physiognomy, by a look of contentment of which the exaggeration con-

stitutes the *sardonic laugh*. The next day, or a few days after, the trismus becomes marked, and the jaws can only be half opened between the paroxysms, which come nearer together; the muscles of the face become involved, and give to the physiognomy the expression of the *risus sardonicus*, of which we have just spoken. The disease is established, and the generalization of the contraction is brought about, in a nearly determined order; the extensors of the neck contract, causing an embarrassment of the movements of the nucha, which may be more precocious, and which may constitute, with the trismus, one of the initial symptoms; the lower limbs become stiff, adducted and extended; the contraction of the abdominal muscles hollows and hardens the belly, and the extensors of the vertebral column curve it more or less backwards, thus producing *opisthotonos*. The upper extremities are spared in mild cases, but invaded more or less rapidly in grave cases; the spasm is then generalized, except as to the diaphragm and muscles of the larynx, upon the integrity of which depends the life of the patient.

Besides this contraction of the muscles, which soon becomes continuous, and is already painful, there are observed, at gradually diminishing intervals, *very painful paroxysms*, which supervene under the influence of the least external excitation, or even without appreciable cause. The contraction of the muscles already attacked is increased, and the spasm seizes the groups still relaxed, those most affected remaining contracted, while the others relapse into resolution until the following crisis; the patient remains silent, or utters inarticulate groans, and sometimes actual cries.

Frequently these crises are accompanied with more or less abundant *sweatings*, which are considered as favorable, and which an effort is made to promote, as we shall see hereafter; the patient ordinarily takes with pleasure such food as the spasm of the jaws and of the pharynx permits him to swallow between the crises. *Insomnia* and *constipation* are habitual. In regard to the bladder, there is frequently observed *dysuria*, sometimes complete *retention* which it is necessary to watch. *Cutaneous eruptions* have also been described in some cases, but are probably due to the medication with chloral or opium. The *intelligence* remains habitually perfect until the end; delirium is always a very grave symptom, and often coincides with a high temperature. Death is, unfortunately, the too frequent termination of the disease, but recovery is also possible; we shall recur again to these modes of termination.

Varieties.—The form which we have described, and which is the average type of traumatic tetanus, is susceptible of numerous modifications, the principal of which constitute varieties of tetanus which we shall successively study, and of which the distinctive characters result from (1) the etiology, (2) the mode of onset, (3) the degree of generalization, and, finally (4) the duration of the disease.

(1) In accordance with the *etiology* of the affection, there may be distinguished *traumatic tetanus without wound*—consecutive to fractures, luxations, violent contusions, etc.—scarcely distinct from the form already described, but beginning more often by phenomena referred to the seat of injury, and ordinarily slower and more benign; and *spontaneous tetanus* from cold (*a frigore*)—so-called rheumatic tetanus—the onset of which may be either sudden or insidious. This may be preceded for from one to eight days by the prodromes of febrile disease, *malaise*, lassitude, and chills, accompanied by symptoms which should arouse the surgeon's attention—*dysphagia*, tendency to an exaggerated extension of the limbs and of the trunk, especially at night, and pains along the spine. The beginning of the contraction occurs here also in the elevators of the lower jaw, though it has been sometimes observed in the lower extremities (Bouchut); otherwise the course of this disease differs in nothing from that of traumatic tetanus, but in Europe,

contrary to what has been observed in warm countries, it is less dangerous than that affection.

There remain two varieties of tetanus of special etiology, the *tetanus of the new-born*, and *puerperal tetanus*. Let us first dismiss the latter, which presents nothing special; it is a traumatic tetanus consecutive to a uterine wound, as it is observed, though seldom, after traumatism of the non-gravid uterus—ablation of mucous polypi, dilatation of the cervix, etc.; perhaps we should take into consideration, as a predisposing cause, the physical and moral depression which especially follow abortion.

In regard to the *tetanus of the new-born* (*trismus neonatorum sive nascentium*, *locked jaw*), its nature is very obscure, and even its existence is disputed since the labors of Parrot, who has demonstrated that, in our climate at least, the affection which had been described by previous writers under this name, was only a form of eclampsia due to uræmic brain-disease. Its symptoms, moreover, differ from those of true tetanus; it begins about the end of the first week after birth; the child is restless, cries, and vomits; its dejections are greenish; its facial expression pinched; and its lips earthy; then the spasm occurs, at first upon the face, next at the nucha and at the back, manifesting itself by cramps and clonic convulsions which terminate in collapse; finally, dysphagia supervenes and the child dies in coma or during a paroxysm. It is possible, however, that there exists in warm countries a true tetanus of the new-born, depending upon the umbilical wound or upon chilling. [According to Marion Sims and P. A. Willite, of South Carolina, *tetanus nascentium* is a traumatic affection, resulting from displacement of the occipital or of one of the parietal bones, and often avoidable by changing the child's position, so as to vary the point of pressure as it lies on the bed or pillow.]

(2) The *mode of onset* permits us to distinguish two very important varieties of tetanus, that which begins with trismus, and which we have described, and that which begins at the point of injury, a variety which Follin distinguishes from tetanus under the name of *secondary traumatic spasms*.

The degree of relative frequency of these two modes of beginning is not yet exactly established, but at present there is a tendency to admit that the second is more frequent than the old authors thought, a very important fact in regard to treatment. The onset at the point of injury does not, indeed, always occur with "a sharp shock and intense pain in the injured limb," as said by Follin, the spasms then following at this point and becoming gradually generalized. On the contrary, in the majority of cases of traumatic tetanus, the pains and cramps of the injured limb are not violent; their existence may be overlooked if the patient is not carefully questioned upon this point, and the trismus is then the first symptom *observed*. These *pains at the point of injury* may persist during the whole course of the disease, and precede the crises, constituting thus a kind of *tetanic aura*, the existence of which is the most trustworthy indication for neurotomy or for amputation.

When the onset does not occur at the seat of injury, trismus is not always the initial phenomenon; it was entirely absent in one case, and in another the spasms affected the depressors of the jaw. These peculiarities are of no importance, but it is not so with the primary or rapid invasion of the muscles of the pharynx, which constitutes the *dysphagic form* of tetanus, a variety of very grave prognosis. These are the cases that Rose would have described under the name of *hydrophobic tetanus*. In this connection may be mentioned a case published under that title by Kirchhoff,¹ a case which was somewhat complex on account of the lesions of the corpus striatum found at the autopsy,

¹ Berlin. klin. Wochenschrift, 1879, No 25.

and in which the mere sight of liquids determined a paroxysm of opisthotonos.

In reference to the period elapsed since the reception of the traumatism, the time of onset of tetanus may vary from a few hours to several weeks; sometimes it occurs only after the cicatrization of the wound. The course of the disease is generally the more rapid as its onset has been more precocious.

(3) With regard to the *generalization of tetanus*, the invasion of the muscles of inspiration is of capital importance as regards prognosis, and it is the precocity of this invasion in the dysphagic form, which constitutes its danger. Those cases must also be noted, in which the spasm remains limited to trismus, with or without slight invasion of the lower extremities; these cases belong to the *slow form*, and consequently are usually benign; but an exaggerated confidence is to be guarded against, and it must be remembered that *generalization is always possible*, and that it has been known to supervene and prove fatal after the contraction had remained for several weeks confined to the jaw.

(4) With regard to the *duration of tetanus*, a *rapid form* and a *slow form* have been described, the first being always fatal, and the second always ending in recovery, according to some authors, no matter what be done—a view which seems to be exaggerated, and which will be hereafter discussed in connection with prognosis.

The *slow form*, or *chronic tetanus*—to which variety belong most cases of spontaneous tetanus met with in our climate, and those in which the onset occurs a long time after the injury—runs its course in two months at most. The contraction may invade all the muscles and cause death, sometimes quite suddenly, but more often the termination is favorable, and generalization does not occur. According to Küssmaul there exists an *abortive tetanus*, characterized by its long duration, the mildness of the tonic contractions, their extension to a great number of muscles, and the absence of sudden shocks.

The *rapid form*, which includes *acute* and *hyperacute tetanus*, ends most frequently in death in the course of a few hours or a few days. Bardeleben cites the case of a negro under his care, who died from tetanus a quarter of an hour after receiving a wound of the thumb. The onset is generally not far removed from the period of the traumatism; the pharynx and larynx are soon invaded, as well as the respiratory muscles; and the muscular contractions are from the start permanent, and without complete remissions between the paroxysms, which are very near together. It is in this form that the violence of the contractions may determine muscular ruptures.

TERMINATION OF TETANUS.—*Death* is the most frequent termination of tetanus, especially when traumatic, but it is far from being constant, and cases of cured tetanus abound at the present day in medical literature. A fatal termination may be anticipated from the beginning, when the course of the tetanus is very rapid, and when the first spasms are very violent; death then occurs during the first four or five days of the disease. In cases where the progress of the disease is not so overwhelming, the approach of death is generally announced by the elevated temperature, by the delirium, and by the frequency, smallness, and irregularity of the pulse; but it depends especially upon the generalization of the contractions, and in particular upon the invasion of the respiratory muscles, and perhaps of the heart. The most frequent cause of death in tetanus is, in fact, rapid or slow asphyxia. Patients with tetanus may die from pulmonary inflammations (Verneuil)—pneumonia or capillary bronchitis—which cause sudden and considerable elevation of temperature. Death may also be the consequence of the general disturbance of nutrition,

and of nervous exhaustion, favored no doubt by the difficulty and sometimes the impossibility of sufficient alimentation; finally, it may also be due to spasm or paralysis of the heart; it seems to occur very seldom without the influence of some complication.

When, on the contrary, *recovery* is going to take place, the beginning of the disease is more insidious and more distant from the date of injury, the trismus continues several days without being complicated with other spasm, and the patient presents neither anxiety nor elevation of temperature; the contraction may, in mild cases, remain limited to a small number of muscles, as we have seen; if generalization does occur, it does not continue a long time; the violence of the contractions diminishes; the muscular groups are gradually relaxed; and soon spasm, which still embarrasses large movements, occurs only at the moment of voluntary contraction, to disappear completely after a period which is sometimes of considerable length. The patient now enters upon convalescence, but he is a long time in recovering, and only slowly regains his strength. This long convalescence demands very careful watching, since relapses are much to be feared, and readily supervene under the influence of cold. We have seen that elevation of temperature may also be observed in benign cases; this disappears at the moment of recovery, but the lowering of temperature is not always a favorable sign, since it has been seen to precede death.

DIAGNOSIS OF TETANUS.—The onset of tetanus may sometimes not be recognized, to the great disadvantage of the patient, and the initial trismus may be confounded with a contraction of the elevators of the lower jaw consecutive to an *inflammatory affection* of the alveoli, teeth, or gums, or of the maxillary bones themselves, and the stiffness of the neck which accompanies and occasionally precedes it with a *rheumatic torticollis*. This error may be avoided by remembering that in these cases the efforts which are made to overcome the resistance of the muscles does not determine, as in tetanus, painful spasms with momentary exaggeration of the contraction. The converse error is yet much more easily avoided, except perhaps in cases of *temporo-maxillary arthritis*, which, however, a methodical exploration of the region ought to permit to be recognized. Finally, the possible existence, although rare, of *partial tetaniform cramp* must be borne in mind—a kind of essential, tonic spasm which is especially observed in the territory of the motor branch of the trifacial nerve (*masticatory cramp* of Romberg), and which is distinguished by the long duration and harmlessness of its symptoms.

During its stationary period, the remitting stiffness of the muscles, the painful paroxysmal spasms, and the characteristic aspect of the physiognomy, ordinarily render the diagnosis of tetanus evident. There are, however, certain affections which may, occasionally, lead to confusion. I shall not speak of the secondary traumatic spasms, of Follin, which are only cases of tetanus beginning at the point of injury. In *hydrophobia*, the complete muscular resolution between the paroxysms, the wildness of the eyes, the excitement and terrified expression of the patient, the continual thirst, the aversion for liquids, and the abundant salivation, sufficiently characterize the disease, and if a few of these symptoms may be exceptionally met with in tetanus, and may justify, as we have seen, the name of hydrophobic tetanus, the confusion is, nevertheless, only theoretical, and may be readily avoided, clinically, by study of the course of the disease, and by a careful analysis of the symptoms. The mistake, however, seems to have been made, and, according to Brouardel, we may consider as examples of tetanus the cases of hydrophobia, reported by authors, in which the symptoms have begun within 24 or 48 hours after the bite. Sabatier cites a case of tetanus consecutive to a fracture of the leg,

which was complicated with a true hydrophobia, and, finally, Girard¹ has attempted to demonstrate the identity of the two diseases. The principal elements of diagnosis are the much longer incubation in hydrophobia, varying between three and twelve weeks, and the complete remission of the contraction in the intervals between the hydrophobic paroxysms.

Spinal meningitis may be distinguished by the cyclical course of its temperature, and by the different type of its contractions, soon followed by paralysis. It seems equally difficult to admit a possible confusion between the tonic spasms of tetanus and the clonic convulsions of *epilepsy*, which are accompanied by a complete loss of consciousness. The much more rapid course of the symptoms, with intervals of absolute remission if the poison has been taken in several doses, permits the recognition of *poisoning by strychnine*.

The diagnosis of tetanus may be rendered more difficult if it is complicated with *hysterical phenomena*, which more or less distort its usual type; the great variability in the manifestations of hysteria do not permit the laying down of rules for diagnosis upon this subject. It will be the part of the practitioner to endeavor to separate, in each case, that which belongs to each of these two diseases.

The diagnosis of tetanus of the new-born from uræmic brain-disease of tetanic form, has not yet been referred to, but we have seen that the existence of true tetanus is doubtful in these conditions, and we must therefore wait for new observations upon this point.

Finally, ought tetanus to be distinguished from *tetany* (*intermittent tetanus, contraction of the extremities*); or should this, as it is by some authors, be considered one and the same disease with spontaneous tetanus? The mild cases, in which the contraction, being frankly intermittent and brought back by compression of the limb, is limited to the extremities, seem evidently quite distinct. But there are grave cases, where the contraction is generalized, and where the disease may become fatal. Although the mode of onset, the course of the contraction—which goes from the extremities to the trunk—and the possibility of causing it by compression of the limbs (characters indicated by Trousseau), may permit the recognition of tetany, yet the existence of this grave form tends to affirm the physiological relationship, if I may venture so to speak, of these two clinically distinct affections.

PROGNOSIS.—From what has been said above, it results that tetanus is a very grave disease, and that death is always to be feared, even in the forms apparently the most benign; but its prognosis is far from being fatal. It is a little less grave in cases of spontaneous tetanus and traumatic tetanus without wound, and in those which begin a long time after the traumatism. The gravity of the traumatism itself, does not seem to have any influence upon that of tetanus. The cases in which the onset is by trismus, are more grave than those in which pains and centripetal convulsions are observed in the injured limb; at least the latter are much more accessible to active intervention. Finally, much importance has been attached to the duration of the disease; it is true that the slow forms are less grave, but we have seen that death may yet occur at the end of several weeks.

It is important to inquire what may be the influence of treatment upon the termination of tetanus. Must we maintain the absolute distinction into two forms, the one acute, inevitably mortal, and the other chronic, which recovers by itself, and in which the sole part of therapeutics is to prevent death by asphyxia and give the patient ease? I believe it more correct to

¹ Sur la non-existence d'un virus rabique. Lyon, 1827.

say, with Richelot, setting aside the overwhelming (*foudroyant*) forms, which seem beyond the resources of art, that the acute forms have never been directly cured, but that treatment may make chronic some cases of tetanus which have begun as acute, and may stop generalization and death in some cases in which they would occur, if the disease were abandoned to itself.

TREATMENT OF TETANUS.—Without affirming, as does Rose, that tetanus may always be attributed to a mistake made in the treatment, it is evident that its development can but be favored by cold and by unseasonable irritation of wounds, and that the removal of these causes should enter into the *preventive treatment* of tetanus.

A question more grave is that of *preventive amputation*, proposed by some authors when tetanus occurs in successive cases. The majority of surgeons reject the operation when the traumatism itself does not indicate it, but they admit that the existence of an epidemic of tetanus may incline the balance in favor of amputation in doubtful cases. I mention here, in order not to have to recur to them, the *accessory means* employed for special indications: the wedge of wood for separating the teeth—useless, since the space situated between the last molars and the coronoid process of the inferior maxillary bone always permits the passage of an œsophageal tube, which may also be introduced through the nasal fossæ (but it must be remembered that an irritation of the larynx may cause spasm and sudden death); nutritious enemata when alimentation by the mouth is not possible; purgatives from time to time; catheterization in case of retention of urine; and, finally, tracheotomy, which is indicated in case asphyxia through spasm of the glottis constitutes the principal danger.

The innumerable methods which have been extolled as *curative measures* for tetanus may be arranged, as is done by Richelot, in three classes, according as they endeavor to suppress the initial irritation, to modify the state of the nerve-centres, or to directly check the muscular contraction. In the first rank should be placed the *surrounding conditions*, which, according to Renzi, constitute a sufficient treatment. The Italian surgeon places patients with tetanus in an isolated, dark, and well-warmed room, where they remain in silence and the most absolute quietness. Without being as exclusive as he is, it must be acknowledged that these precautions are valuable adjuvants to other means of treatment, and that they should be employed whenever it is possible. In order to maintain around the patients a warm and even temperature, it is important at least to cover them with an eider-down quilt. These precautions will prevent the external excitations which determine most of the paroxysms.

But it is necessary to endeavor to overcome the cause itself of tetanus, the peripheral irritation which has been its point of origin. Such is the object of *local treatment*, the only rational means of arresting the malady at its beginning. The surgeon must inquire if there be not some evident, local cause of irritation, painful granulations which can be cauterized, or a too sensitive cicatrix which should be destroyed with the bistoury or caustics. Apart from these indications, we must confine ourselves to an infrequent but very careful dressing of the wound, and not irritate it with blisters or ether spray. If this simple treatment, in connection with internal medication, which we shall study presently, does not cause a rapid amelioration of the symptoms, it becomes necessary to adopt more active measures, and to choose between amputation, neurotomy, and nerve-elongation or nerve-stretching.

Amputation is only admissible when it would be justifiable even without the complication of tetanus; at the present time it is known that an amputa-

tion, during the height of this disease, has not the dangers which might theoretically seem connected with it.

Neurotomy, the efficacy of which has been made unquestionable by the instantaneous amelioration and rapid recovery which have followed it in some cases, has the inconvenience of always leaving as a result a more or less complete paralysis, notwithstanding the possible re-establishment of the nervous functions by regeneration, or through collateral channels. It is especially indicated when the spasms begin near the seat of injury, before their generalization; but it may still contribute much to recovery when generalization has occurred, by removing the cause which keeps up the spinal irritation. The choice of the nerve to be cut, is determined by the surgeon's knowledge of anatomy, by the pain upon pressure, and, when this symptom exists, by the course of the tetanic aura, which then constitutes the most precise indication for the operation. The operation should be done as soon as possible, and at a greater distance from the wound as it is more delayed, on account of the possible development of an ascending neuritis. The incision should be small, and should be dressed with care, so as not to create a new cause of irritation. *Polynurotomy* has the inconvenience of increasing the traumatism, and of leaving as a result a too great infirmity. I shall refer to this point again in connection with the operations which are practised upon nerves.

Together with neurotomy are to be considered the crushing and elongation of nerves, which are indicated by the same conditions. The *crushing* of nerves acts also in interrupting the nervous current; it has, perhaps, the inconvenience of being less certain, but the persistence of the neurilemma renders more constant and more rapid the regeneration of the nerve-trunks.

Finally, the operation of *elongation* or *stretching*, which only momentarily interrupts the conductivity of the nerves, has the great advantage of not leaving after it persistent paralysis; this more easily permits the surgeon, in the absence of precise indications, to operate upon several nerves of a limb, or even upon all, which certain writers have laid down as a rule. Already several cases of nerve-elongation in tetanus, followed by recovery, have been reported. If its efficacy were demonstrated, it would be preferable to both division and crushing of nerves.

The *internal medication* intended to modify the condition of the nerve-centres should always be associated with the local treatment. Considering spinal congestion as the cause of the symptoms, antiphlogistic, contra-stimulating, and alterative remedies have been recommended, with the application of revulsives along the spine. Labbé refers to a patient of Lisfranc's, who recovered after 19 bleedings and the application of 772 leeches. This method may be of service, employed in more moderate measure, in some cases. Among remedies which have been especially resorted to in tetanus must be mentioned chloral and opium.

Chloral, though indicated by its physiological properties and its special action upon the reflex function of the spinal cord, has never arrested the disease, as has neurotomy, for example, and does not prevent its offensive recurrences; but it quiets the spasms in an unquestionable manner, and, if it has often failed, perhaps because local treatment and the maintenance of good surrounding conditions have been neglected, nothing proves that some cases of tetanus which have remained local with chloral would not have become generalized without it. In every case it is a very useful adjuvant, which gives the patient comfort, and permits the disease to run its course without mortal accident. Nevertheless, it does not always prevent death from occurring by nervous exhaustion, notwithstanding the localization of the spasms; perhaps even some deaths which have taken place in collapse may have been due to its use in too large quantities. It may be administered by

the mouth or by the rectum, or may be introduced directly into the veins. Administration by the mouth should be preferred, as long as it is possible and sufficient, and we should always begin in this way. Chloral should be given by grammes until muscular relaxation and sleep are obtained, and its action should be kept up with care for quite a long time, only permitting the patient to awake in order to take food. The time during which this mode of treatment should be employed, is a matter for experiment, varying in each case. It may be said, however, that chloral has been administered more than a month without producing *gastro-enteritis*. There are some patients, however, in whom this medicine determines vomiting; then, as when dysphagia is very marked, it is necessary to give the drug by the rectum in the same doses. It is only when administration by the mouth or rectum is not borne, or when the effect is not sufficient notwithstanding the use of quite large doses, that another plan may be resorted to—intra-venous injection—chloral being too caustic to be employed with advantage hypodermically. Particularly extolled by Oré, of Bordeaux, intra-venous injections of chloral are advised by surgeons of authority. The action of chloral used in this way is more rapid and more durable than when employed otherwise. It has been objected to this method, that it exposes to accidents, and especially to the formation of clots, but these may be avoided by being very careful in performing the operation. Oré advises the employment of a very slender trocar and a syringe with well-graduated piston, provided with a fine strainer, in order to arrest little foreign bodies; the vein must be opened by a direct puncture, after having been made prominent by a circular ligature placed around the limb; the trocar is next withdrawn; the syringe is adjusted to the canula, after a few drops of blood have flowed; and a solution containing 9 grammes (gr. cxi) of chloral in 10 grammes (ʒiis) of water, with a few drops of a ten-per-cent. solution of carbonate of sodium is slowly thrown into the vein. Eight grammes (ʒij) of the solution may be injected each time, if there is no accident, and one or two injections at most are given in the 24 hours. An induction battery should be at hand, in case of syncope.

Opium, *morphia*, and *laudanum* begin by congesting the spinal cord, and have no effect against tetanus except in very large doses, at the price of serious digestive disturbances. Therefore, according to some authors, they should be absolutely banished from the therapeutics of tetanus; others, on the contrary, recommend them when chloral does not succeed. There are, further, extolled as remedies against tetanus, with the object of modifying the nerve centres, a host of medicines, of which I shall only name the chief: *Belladonna* and *atropia*, which lessen congestion of the nerve-centres, and may serve as adjuvants to a more active method; *Ergot*, which indeed acts upon the vessels of the spinal cord, but may determine gangrene; *Calabar bean* and its alkaloid *eserina*—1 to 4 milligrammes (gr. $\frac{1}{16}$ to $\frac{1}{16}$) by subcutaneous injection—which causes a temporary relaxation, perhaps by acting directly upon the muscles; *Bromide of potassium*, which, in order to act, must be employed in dangerous doses; *Chloroform* and *ether*, by inhalation, which may cause death during the period of excitement, and which necessitate, on the part of the physician, continual attention, rendering their employment not practical—it is the same with *nitrite of amyl*, the effects of which are yet incompletely known; the *continued currents*, which have only a temporary action, and upon the employment of which there is, moreover, a difference of opinion, Le Fort and Verneuil recommending ascending currents, and Legros and Onimus, and Dubreuil, on the contrary, descending currents. There have been extolled, moreover, hemlock, tobacco, nicotine, aconite, salicylic acid, cannabis indica, alcohol in large doses, etc. I may further mention *diaphoretics*, which constitute a good complement of treatment, and particularly steam baths, provided

that they can be given in bed without too much disturbing the patient. *Tepid baths* seem more rational than cold baths and cold douches, from which good effects have, however, sometimes been obtained; both have the inconvenience of necessitating movements which are very painful and very unpleasant. Finally, it can be understood that the *sulphate of quinine* has been employed with success against the malarial forms.

I shall say but one word as to the treatment which aims only to directly stop the muscular contractions: it is a symptomatic medication, necessarily insufficient, and temporary in action. Thus act acupuncture, the different liniments which have been devised for the treatment of tetanus, the sulphocyanide of potassium, and curara. In regard to the latter medicine, I may notice an interesting case by Hoffmann,¹ in which the curara was administered by intra-venous injections, eight in number, each containing 17 milligrammes (gr. $\frac{1}{4}$ +) of the medicine. This case is not favorable for the treatment with curara, since the patient died from arrest of the heart's action for which, perhaps, it was responsible; but the case is singular in the fact that, at the autopsy, there was found no vascular or circulatory lesion, notwithstanding the eight injections given in a few hours, which proves the harmlessness of intra-venous injections made with care.

Conclusion.—To summarize: in the presence of a case of tetanus it is necessary to put the patient in the most favorable surroundings, and at once to administer chloral until resolution of the spasms is obtained; at the same time local treatment must be resorted to, that is to say, any cause of irritation which may exist in the wound must be removed, and if none can be found, or if this first interference is not sufficient, amputation, neurotomy, or nerve-elongation must be immediately decided upon. To this fundamental treatment may be joined some accessory means, such, for example, as the use of diaphoretics and belladonna.

Thanks to this rational treatment, without hoping yet to triumph over the hyperacute forms, a certain number of acute and chronic cases of tetanus may be arrested and cured.

OPERATIONS WHICH ARE PRACTISED UPON NERVES.

Several operations are practised upon nerves. These are *nerve-suture*, *nerve-elongation* or *nerve-stretching*, simple division or *neurotomy*, and resection or *neurectomy*.

It sometimes occurs that the nerves which are in the neighborhood of bones are found, after a fracture for example, inclosed in an osseous canal. This has been observed in the case of the radial [musculo-spiral] nerve at the surface of the humerus. In these cases an operation is performed to *dislodge the nerve* with chisel and mallet.

The same operation has been done to *isolate the nerve* from the lardaceous, fibrous tissue which sometimes surrounds and ensheaths it as a result of chronic inflammation. The older surgeons practised *cauterization of nerves*, in cases of neuralgia, but this operation is at the present day abandoned.

I. SUTURE OF NERVES.

HISTORY.—We may divide the history of the suture of nerves into three periods. The first, from the date of Hippocrates and Galen to 1776, the time

¹ Berlin. klinische Wochenschrift, No. 43, 1879.

when Cruikshank established the reality of the cicatrization of nerves; the second, from 1776 to 1864, the epoch of the publication of the work of Weir Mitchell upon Gunshot Injuries of Nerves, after the war in the United States; the third, finally, from 1864 to the present time (Poinso).

During the first period, the possibility of the cicatrization of nerves was denied by some (Hippocrates and Galen) and admitted by others, some of whom (Guillaume de Salicet, Lanfranc, Guy de Chauliac, etc.) even recommended the suturing of these organs. Unfortunately, the confusion which then existed between nerves and tendons does not authorize us to dwell upon the opinions of these authors. At all events, this practice was very little in favor, since Ambroise Paré does not even speak of it. After the labors of Cruikshank, Fontana showed the nervous nature of the cicatrix of nerves, and recommended their suture, which was also subsequently advised by Dupuytren, who, however, admitted the possibility of the cut nerve being substituted by the anastomoses to which Horteloup attributed, even exclusively, the re-establishment of the functions of the peripheral end.

Finally, the clinical period opened with the work of Weir Mitchell and the observations of Nélaton, Laugier, and Richet, at the same time that the apparent contradictions between the clinical and experimental results were explained by the investigations of Messrs. Arloing and Tripier on "sensory-motor substitution." We shall first study the indications and operative manual of nerve-suture, and afterwards we shall see the results furnished by this operation in the small number of cases that have been published, and we shall inquire what conclusions can be drawn regarding its utility in respect to the re-establishment of nerve-function.

INDICATIONS.—Although, according to some authors (Vulpian, Tillaux, Magnien, Dubrueil, Poinso) every complete division of a nerve is amenable to the suture, agreement upon this matter is far from being unanimous, and from this point of view it becomes important to divide complete sections of nerves into three categories, according to whether they are simple, complicated with more or less considerable destruction of the neighboring parts, or accompanied with crushing or laceration of the cut extremities.

When the section is clean-cut and simple, without extensive wound of the integument, the suture should not be resorted to unless the separation is considerable; but it may be required when there are found extensive lesions of the skin and neighboring parts, so that position alone is not sufficient to cause the extremities of the nerve to come together (Jamain and Terrier, Tripier). The indication for suture is still more urgent if the nerve has experienced a loss of substance. When the section of the nerve is accompanied with crushing, most authors agree in advising suture after resection of the contused part, except Tripier, according to whom this practice increases, without any benefit, the causes of inflammation of the nerve and soft parts. Finally, reference must be made to the opinion of Follin, who positively rejects the suture of nerves.

This operation should naturally be done as soon as possible after the accident. It is important to perform it before the appearance of suppuration. It may, however, still be practised in order to reconstruct a nerve, the extremities of which have separately cicatrized (Tillaux, Letiévant); it is then necessary to make a more or less extended resection of the nerve extremities, or to employ one of the procedures of nervous autoplasty, described by Letiévant, which will be mentioned in connection with the mode of operating.

OPERATIVE MANUAL.—The operation of nerve-suture includes four stages: (1) Searching for the ends of the cut nerve; (2) Their examination and

freshening, if this is necessary; (3) Passing the threads; and (4) Their adjustment.

(1) The *search for the two ends* of the cut nerve is generally easy, since these structures present but little contractility; nevertheless it demands accurate anatomical knowledge. If the wound is narrow and deep, it will be of great advantage to enlarge it by an incision, parallel to the course of the nerve, in order to spare as much as possible the manipulation of the wound, which prevents immediate union, and also in order to facilitate the passing of the threads. For this first stage of the operation, Esmarch's bandage will render service; if it be feared that the rubber band, applied from the extremity upwards, may increase the separation of the nerve-extremities by pushing back the upper end to a higher point, it will be then preferable to employ only the band with rings (See Vol. II., page 527), which I long since proposed to take the place of the tube. The two extremities of the nerve are found without great difficulty; it may happen, however, especially when there are extended lesions of the neighboring structures, or when the nerve has undergone a loss of substance, that it may be impossible to find the central end; in this case, *two different nerves may be united together* (Flourens). If several nerves have been divided, the lower end of the most important nerve must be united to the upper end of another; for example, the lower end of the median nerve to the upper end of the musculo-cutaneous nerve; if the musculo-cutaneous be not divided, the *grafting* of the lower end of the median to the musculo-cutaneous nerve may be attempted, after freshening a small surface of the latter (Létiévant).

(2) The two ends of the nerve being found, if the section is clean-cut and recent, it only remains to pass the threads; if, on the contrary, the extremities of the nerve are crushed, or if they have become separately cicatrized, most authors agree in advising to *resect a portion of variable extent*, and then to apply the suture, as if the case were one of recent wound.

(3) We now come to the most delicate stage of nerve suture—to the *passing of the threads* destined to connect the two extremities of the divided nerve-trunk. We shall successively examine the kind of needle and of thread which should be employed, the number of threads to be used, and the point at which they are to be passed. Generally, for this operation, ordinary, fine suture-needles are employed. Wolberg, of Warsaw, has proposed for this purpose a special needle; he has given it the shape of a curved sword, very thin and lance-shaped in the direction of its length, and with an oval eye, large enough to receive the thickest catgut. This author has examined with the microscope nerves sutured with this needle, and has found that the nerve-fibres have been notably less damaged than when an ordinary needle has been used. All kinds of thread have been employed. Gen recommends catgut; H. Page, catgut or silk; Richet, silk; Vulpian, linen-thread; Jamain and Terrier, silk or silver wire; Létiévant and Nélaton, silver wire. To sum up, the choice should lie between catgut, Chinese silk, and Florence thread.

As to the number of points of suture and the part of the nerve-trunk which they should traverse, agreement is equally wanting. Weir Mitchell, in his experiments upon animals, obtained sufficient approximation by passing one or two threads into the neighboring tissues adherent to the sheath of the nerve; Richet advises placing two threads involving only the neurilemma; Wladowski also is of the opinion that the neurilemma only should be included in the loop of thread, claiming that the consecutive paralysis is more marked when the nerve substance is involved; finally, others pass the thread through the nerve-substance itself (Nélaton, Wolberg, Vulpian, Tillaux, Létiévant, Laugier). Among these, some traverse the nerve through and through, the

upper end from before backwards, and the lower end from behind forwards (Létiévant); others do not completely traverse the nerve-trunk, and make the thread come out, either at the lower (Nélaton) or at the middle part of the surface of section (Vulpian). Almost all advise that the threads should enter and come out very near the place of section, in order to obtain a more exact adjustment, and to avoid angular deviation of the two ends. One thread only is usually employed; two should not be used unless the nerve be very large.

(4) The adjustment also should be as exact as possible. It is effected, according to the kind of thread used, either by making a double knot, or by twisting the thread with forceps; or the surgeon may do as Nélaton did, in order to facilitate the removal of the threads—pass them into a Galli's tube, at the extremity of which they are bent upon themselves; whatever may be the procedure employed, the tension used must be moderate. If the division of the nerve be accompanied by division of the tendons, Tripiér recommends, when the threads have been passed, that they should not be tightened until after the completion of the suture of the tendons.

The extremities of the nerve once in contact, it remains only to suture the wound of the integument; the threads which unite the ends of the nerve are brought out at one of the angles of the wound, and are fastened with adhesive plaster, as recommended by Létiévant, if silver wire has been used. The essential condition of the dressing is to avoid suppuration, and to obtain union by the first intention, at least in the deep part of the wound. It is best then to follow, during the whole operation, the rules of the antiseptic method, and to apply over the wound a Lister dressing after having provided means of drainage, if necessary. Besides these precautions, it is required, in order that union by the first intention should have any chance of success, that the operation should be done before the establishment of suppuration, and that, as we have said above, too prolonged manipulation of the wound should be avoided, and especially bruising of its edges and injuring of the tissues which surround the nerve, in the process of searching for the two ends. To finish the dressing, the limb must, in addition, be immovably fixed in such a position that the threads shall not be pulled upon; and this precaution is particularly important when the nerve has undergone a loss of substance. The best means to maintain the limb in a favorable position is to apply a plaster splint immediately after the operation. When silver wire has been employed for the nerve-suture, the wire must be removed at the end of fifteen days. Gen, in fact, has observed that union is generally complete on the twelfth day; it is true that his experiments were made upon animals.

It is difficult to say what is the maximum of separation of the extremities of nerves which permits the suture. Nélaton was able to use it even after having resected a length of six centimetres ($2\frac{1}{3}$ inches) of the nerve-trunk. If the separation is very great, the operation of *nerve-autoplasty with flaps*, proposed by Létiévant, may be employed. This author advises in these cases to make with a bistoury, in the upper end of the nerve, a button-hole slit, beginning five millimetres ($\frac{1}{5}$ inch) from its extremity, and going three or four centimetres (1 to $1\frac{1}{2}$ inches) above; at the upper part of the slit, in drawing out the bistoury, one of the lips is divided transversely, thus forming a flap which is turned back in the direction of the lower end; the same operation is performed upon the lower extremity of the nerve, the flap from which is joined by its freshened surface to the freshened surface of the former, and kept in this position by a point of suture. The results obtained by the author himself are, however, not very encouraging, since in the two cases which he cites he obtained no appreciable result.

Finally, the experiments of Gluck, of Berlin, in *neuroplasty by transplantation of nerves*, must be referred to. This author has resected in chickens

three or four centimetres (1 to 1½ inches) of the sciatic nerve, which he has replaced by a piece of the sciatic nerve from a rabbit, sutured at both of its extremities. The chickens thus operated upon walked as well as those upon which direct suture of the sciatic had been practised, while section of the sciatic without suture or autoplasty produced a paralysis of this nerve which was still complete at the end of ten weeks. This procedure is yet in the domain of physiology. When the separation of the ends of the nerve is considerable, and they cannot be brought in contact, the *tubular suture* of Gluck and Vaulair may be tried. The aim of this is to prevent the obliteration of the space which separates the two segments by the interposition of a Neuber's osseine tube. Gluck has only obtained negative results, but Vaulair has seen, he says, after a delay of four months, the regeneration of a nerve-trunk measuring five centimetres (2 inches). He has determined that the regeneration is effected by *centrifugal granulations* arising from the central end, as has likewise been shown by the labors of Eichhorst, Ranvier, and Hahn. He adds that a small portion only of the new fibres unite with the degenerated fibres of the peripheral end.

RESULTS.—The suture of nerves favors cicatrization and hastens the process of regeneration of the peripheral end, but it does not prevent degeneration from beginning; in a word, immediate union of a nerve is impossible, even with the suture.¹ Cases of rapid regeneration, in eight or fifteen days, have been observed only in very young animals, and never in man (Letiévant). Such is to-day the opinion of the great majority of authors, and we need not recall here all the objections that have been made to the alleged examples of immediate union of nerves, which have been set forth in connection with wounds of nerves. The immediate union of nerves without degeneration of the peripheral end is, however, defended by some modern authors, among whom may be named Schiff, Gluck of Berlin, Wolberg of Warsaw, Batowetzki, and Paget.

This operation was at first accused, especially theoretically, of predisposing to *tetanus* and to *inflammatory complications* of the wound, but experience seems to have proved the complete harmlessness of nerve-suture. Eulenberg and Landois have, however, observed, after experimental suture of nerves, intense *neuritis* with deep *suppuration*, and even *purulent infection*. The value of these results is much impaired by the fact that these experimenters operated upon rabbits, animals in which suppuration occurs with the greatest ease. The fact should, however, be taken into consideration, since, as Tripier has well remarked, it might perhaps be the same with man in certain conditions.

CLINICAL OBSERVATIONS.—The cases of nerve-suture which I have collected from authors, number eleven, and belong to Nélaton, Laugier, Hulke, Richet, Verneuil, Letiévant, Kraussold (two), Busch (two), and Herbert Page. Among these eleven cases, two only are given as unsuccessful; they are the two cases of Letiévant, which relate to complicated cases in which nerve-autoplasty with flaps was resorted to; but in examining the other nine, it is seen that four only can be considered as certain successes; they are those of Hulke, Richet, Kraussold, and Verneuil. That of the last surgeon is particularly interesting, and constitutes an actual experiment; in fact, the median and ulnar nerves were divided, and the median, which alone was sutured,

¹ At least the immediate union of the nerve fibres among themselves; but as regards the immediate union of the ends of the nerve by means of the peripheral and interstitial connective-tissue, this is possible, and should, I think, be sought for.

recovered its functions much more rapidly than the ulnar. In the other cases, the effect of the suture cannot be decided; some of the reports are absolutely wanting in details, and the others date the improvement from a period much too near the time of inserting the suture (from the second, from the fourth, and from the seventh day). The most important fact in all these cases is the complete absence of every kind of complication, even in the two cases of Letiévaut. This permits us to believe, notwithstanding the small number of known cases, that the gravity of this operation has been much exaggerated.

[Additional cases of nerve-suture, mostly successful, have been recorded by numerous surgeons, and of 39 cases collected by Weissenstein and Markoe, at least 29 terminated favourably.]

CONCLUSION.—To summarize, the operation of nerve-suture seems to be indicated in all sections of nerves, though, in certain cases, position alone is, perhaps, sufficient to keep the divided ends in contact. The suture appears to favor and to hasten the process of cicatrization and regeneration of the nerve-trunks; and the few cases which we possess permit us to believe that it does not expose the patient to accidents. There are cases reported of division of nerves, with or without loss of substance, which have not caused paralysis. Paulet has collected them in a memoir,¹ without being able to give any satisfactory explanation of them, and other cases have been recorded since; but these cases prove nothing contrary to the regeneration of nerve-tissue—they only show that this regeneration is not the only mechanism by which the function can be restored. Moreover, their rarity makes these cases a clinical curiosity; the absence of re-establishment of the functions of a nerve, when its extremities have become separately cicatrized, remains the rule, and it is the duty of the surgeon, in dealing with a divided nerve, to insure, by every possible means, the approximation of the two ends, since this affords the least deceptive pledge of functional restoration.

II. ELONGATION OR STRETCHING OF NERVES.

HISTORY.—Elongation of nerves was first studied from a purely speculative point of view by a certain number of physiologists and anatomists, among whom may be named Harless and Haber in 1858, Valentin in 1864, and Weir Mitchell in 1872, but it is since elongation has entered into therapeutics, that have been made the more numerous and more accurate experiments of Schleich, Tutschek, Conrad, Vogt, Trombetta, and Brown-Séquard.

In 1860, during a resection of the elbow performed by Nussbaum, the hook held by an assistant very forcibly stretched the ulnar nerve, and the tetanic cramps which had existed in the arm disappeared after the operation, a result which was attributed by this surgeon to the accidental elongation. This idea was confirmed in Nussbaum's mind by a case under the care of Billroth, who, attending in 1869 a patient attacked with epileptiform paroxysms following a violent contusion of the buttock, believed that the nerve was irritated by a splinter of bone, and denuded the nerve without finding anything. The stretching which the nerve had undergone during the operation was sufficient, however, to cause recovery. Accordingly, in 1872, Nussbaum decided to practise the first intentional elongation, for a contraction of the upper extremity consecutive to a contusion; the contraction yielded to the operation. Gartner and Vogt imitated his practice the same year, and the operation was soon introduced into England by Callender, and

¹ Paulet, *Société de Chirurgie*, 1868; M. Sée, *Société de Chirurgie*, 1881.

into France by Verneuil and Blum. At first directed only against neuralgias or cicatricial compressions of nerves, elongation was soon applied to general or partial convulsive affections by Cr  d  , Baun, Verneuil, Gen, Pooley, and others. Langenbuch, Esmarch, Erlenmeyer, and Debove employed it in locomotor ataxia, and finally, Lawrie, Professor of Surgery at Lahore, applied it in the treatment of an  sthetic leprosy.

PATHOLOGICAL ANATOMY.—If elongation of small-sized nerves is made without care, it may determine rupture of the nerve-trunks or avulsion of their roots. But this is an accident of nerve-elongation which exact investigation of the degree of resistance of different nerves will render it easy to avoid. In elongation practised within the limits which will be hereafter indicated, the nerve itself most often does not present any lesion appreciable to the naked eye; the only macroscopic lesions consist in a laceration of the sheath, which gives rise to an audible crackling, and in a rupture of the vessels which are distributed in its interior. These lesions will be more widely distributed if during the operation the limb is not kept extended; flexion, indeed, permits the nerve to be drawn much further from its place.

According to the experiments of Tutschek, the vascular lesions are more marked at certain points which correspond generally to the passage of the nerve into an orifice, or across a fibrous partition.

Authors are not agreed as to the *histological lesions* consecutive to nerve-elongation. According to Valentin, most frequently nothing abnormal is found; according to Schleich, the modifications undergone by the nerve consist in a more or less extended coagulation of the myelin; Tarchanoff has observed, immediately after the elongation, traces of hyper  mia and capillary hemorrhages, and the division, in a certain number of nerve-fibres, of the myelin and axis-cylinders, the sheath of Schwann remaining always intact; finally, Scheving, examining elongated nerves after a certain time, found healthy fibres, especially at the centre of the nerve; fibres in a state of secondary degeneration, above and below the point of elongation; and some fibres in process of regeneration. In fine, elongation seems to cause most frequently the rupture of a certain number of nerve fasciculi. Forceful elongation of large nerve-trunks affects even the spinal cord.

By carrying the elongation further, avulsion of the nerve is produced, either at a point where it is reflected upon itself, or at its root. It may be added that Blum has proposed avulsion as a mode of treating obstinate neuralgia of the superior maxillary nerve. If simple elongation is replaced by *elongation with crushing of the nerve* on the groove of a director, as is done by Verneuil, or between forceps, there will be evidently observed a grinding and more or less complete division of the nerve-trunk, thus producing a kind of sub-neurilemmatous neurotomy.

PHYSIOLOGY.—The physiology of the elongation of nerves includes an inquiry into the resistance and extensibility of the nerve-trunks, and a study of the effect of elongation upon their functions.

The principal experiments upon the *resistance of nerves to traction* are those of Tillaux and Trombetta. The results obtained by these two authors are quite different. Thus, Tillaux caused rupture of the sciatic nerve with a mean force of 58 kilogrammes (128 lbs. Av.),¹ while Trombetta had to employ a force of 84 kilogrammes (185 lbs. Av.); but the great difference in the processes used, must be taken into account. Tillaux, who made his ex-

¹ Symington Johnson caused rupture of this nerve with a mean weight of 59 kilogrammes (130 lbs. Av.). *Lancet*, 1878, vol. i. p. 904.

periments before the discovery of elongation, and from a purely anatomical point of view, drew upon the nerve in the axis of the limb, after having divided circularly the other soft parts and the bone, at the point at which he wished to apply the traction. Trombetta, on the contrary, whose experiments are recent (1881), made them resemble, as closely as possible, the operation of elongation as practised upon the living subject; this gives special interest to his results, of which I reproduce the most important:—

	Kilos.		Kilos.		Kilos.
Supra-orbital branch,	2.720	Seventh cervical branch	23.416	Radial nerve,	27.750
Infra-orbital branch,	5.477	Eighth cervical branch		Ulnar nerve,	26.500
Mental branch,	2.492	and first dorsal,	29.460	Femoral nerve,	38
Fifth cervical branch,	22.820	Brachial plexus in axilla,	17 to 37	Sciatic nerve,	84
Sixth cervical branch,	24.134	Median nerve,	38.18	Popliteal nerve,	52

The results obtained by Gillette for the sciatic nerve agree with the preceding: in 45 elongations practised upon 23 cadavers, at Bicêtre, this surgeon 12 times obtained avulsion of the nerve with a force of from 200 to 75 kilogrammes; 29 times, rupture with from 165 to 42 kilogrammes, not including one instance in which a softened nerve yielded to a traction of two kilogrammes, but in which the softening was evident upon simple inspection; finally, in three cases, tractions of 45, 90, and 200 kilogrammes, caused neither avulsion nor laceration of the nerve.

From these results, it is seen that rupture during elongation is not to be feared as long as the nerve is a moderately large one, since Blum has demonstrated that it is impossible to employ a force of more than 15 kilogrammes (33 lbs. Av.) in making extension with a grooved director. Gillette recommends a force not exceeding 20 kilogrammes (44 lbs.) An attempt has also been made to ascertain what *lengthening* the nerves may undergo under the influence of traction. The conclusions from the experiments of Vogt upon this subject are, that the nerves of man are but little extensible, and that their extensibility diminishes from the centre to the periphery; according to this author, the extensibility of the nerves is exhausted in certain forced movements; for example, in flexion of the thigh upon the pelvis while the leg is extended. This fact, which has been verified by both myself and Trombetta, has led the latter to propose a new method for the elongation of nerves.

Let us now see what are the *physiological changes* determined by this operation. And first, what elongation of the nerve is necessary in order that these changes shall be produced. Weir Mitchell made experiments upon rabbits, and found that slow elongation, limited to the sixth of the primary length of the nerve, did not change its electric excitability. This excitability disappeared much sooner if the elongation was sudden. He adds, that very probably a much less powerful elongation would suffice to withdraw the muscles from the influence of the will, and to hinder the transmission of slight sensory impressions. The extensibility of nerves, however, varies too much in different animals, for the results obtained in one to be applicable to another.

We shall successively consider the changes determined by elongation in the excitability, the sensibility, and the motility of the nerves, and its influence upon the spinal cord and nerve-centres. All experimenters have recognized that direct and reflex *excitability* of nerves disappears under the influence of strong traction; the majority have, moreover, remarked that this excitability increases if the force used does not exceed a certain limit, fixed by Tarchanoff at half of the force necessary to cause rupture of the nerve, which seems a little exaggerated. Finally, according to Conrad and Scheving, the sensory fibres lose their excitability before the motor fibres—a very interesting

result, to which we shall have occasion to revert, and which may furnish us an important guide in the practice of elongation.

Sensibility is increased at the beginning of traction, disappearing more or less completely, and more or less permanently, according to the force employed and the duration of the time of traction, at least in healthy subjects; traumatic palsies have been known to be cured by elongation (Blum, Nussbaum's first case), and Brown-Séquard has demonstrated the more or less rapid return of sensation, frequently with hyperæsthesia, in a limb rendered anæsthetic by semi-section of the spinal cord. Lastly, elongation, practised by Lawrie upon patients attacked with anæsthetic leprosy, caused, in a great number of cases, at least a temporary amelioration, even when the traction had accidentally produced rupture of the nerve.

Motility is less easily influenced by elongation. According to Blum it may be re-established by a slight elongation in some cases of traumatic paralysis. It disappears more or less completely, but always in a temporary manner, when the elongation is violent. Lastly, when the elongation is moderate, although sufficing to produce anæsthesia, only temporary paresis is usually observed. According to Scheving, the paresis is slight, or altogether absent, if the elongation is applied to the central end, while the traction exerted upon the peripheral end determines motor paralysis without anæsthesia. Finally, Valentin has ascertained that the electro-motor quality of the myelin is modified by powerful mechanical actions.

The effects of elongation are not limited to the territory of the elongated nerve; they are also felt, as several observers have recognized, in the nerve of the opposite side. Brown-Séquard, after having rendered animals hemianæsthetic by section of half of the spinal cord, saw sensibility return, after elongation of the sciatic nerve, even in parts not supplied by that nerve. Finally, Mareus and Wiet have produced glycosuria in the rabbit by elongating the central end of the pneumogastric, and even of the sciatic nerve. These facts seem to demonstrate, in spite of the contrary opinion of Vogt, that the effects of elongation make themselves felt even upon the spinal cord and nerve-centres. Gillette, moreover, has been able to directly determine upon the cadaver that tractions exerted upon the sciatic nerve communicate a notable shock to the spinal cord.

It seems equally probable that centripetal elongation of a nerve is propagated to its branches, and may act through them upon the terminal nerve structures. It may be added that, in the majority of experiments, the appearance of quite marked *trophic disturbances* has been noted as a result of the elongation of mixed nerves, but that these disturbances have not been observed after elongations practised upon man, at least to a degree sufficient to constitute a contraindication. Elongation may, however, be followed immediately or quickly by serious accidents, when it is practised upon the cranial nerves, and particularly upon the branches of the Gasserian ganglion. Although several surgeons have been able to perform, without any ill result, elongations of the cranial nerves, notably the branches of the trifacial, it may be feared that this will not always be so. At the Surgical Society of Paris, Tillaux and myself have called attention to the loss of the eye which sometimes follows resection of the superior maxillary bone, and which results from the avulsion of the incompletely divided infra-orbital nerve.

In cases of painless spasm of the muscles of the face, elongation of the facial nerve might be followed, as has actually happened, by more or less lasting, or even permanent paralysis. In these cases I should prefer sub-neurilemmatous neurotomy, or crushing of the nerve. I think then that a distinction should be established between the elongation of spinal nerves and that of cranial nerves, and that the latter should be done only with reserve and pru-

dence, in the fear of immediately fatal reflex effects, or of trophic disturbances, as in avulsion of the branches of the trifacial.

It is evident that the mode of action of nerve-elongation will be differently understood, according as one or the other of the preceding views is adopted, and will be explained by a change in the nerve itself or in the terminal nerve-structures, but the majority of authors agree in recognizing that it most often acts by diminishing the conductivity of the nerve, and not by freeing it from adhesions or pathological sources of compression, as was at first believed.

By what mechanism is the *diminution of conductivity* produced? Is it due to compression of the medullary substance, to a modification of the electro-motor power of the nerve, and to a separation of the myelin and of its sheath (Valentin); to suppression of the elastic pressure of the sheath upon the nerve, or to disturbances of nutrition by vascular lacerations (Harless, Vogt); or must it be explained by an incomplete rupture, as it is by Verneuil, who has, substituted crushing for elongation? The diminution of conductivity being admitted, the therapeutic action of elongation may, with Callender, be explained by a kind of *isolation of the nerve centres*, which permits them to resume their normal action, previously disturbed by peripheral irritation.

As to the direct influence of elongation upon the nerve centres, it appears to have been demonstrated by the physiological experiments which have been above referred to, but its nature is still unknown.

Finally, in certain cases, it may be believed that elongation has acted as any traumatism. This opinion is sustained by a case reported by M. Berger to the Society of Surgery, in March, 1882—a case in which the opening of an abscess beneath the quadriceps femoris muscle caused the disappearance of the lightning pains of ataxia.

To summarize: elongation acts at the same time upon the nerve centres and upon the nerve trunks submitted to traction, most frequently by diminishing their sensory conductivity, probably by the mechanism of an incomplete rupture; but it must be clearly recognized that this explanation does not account for all the facts, and notably for those where a pathological or experimental anaesthesia has disappeared under the influence of treatment. The minute study of new clinical and experimental facts, and the endeavor to determine the exact force employed in each case, will, no doubt, point the way to the true explanation of these phenomena.

CLINICAL RESULTS.—We have seen that, as regards the function of the nerve, elongation, when well performed, has but little influence over motility, and is never followed by persistent paralysis of movement, while, on the contrary, the appearance of a lasting anaesthesia is indispensable to its therapeutic action, when it is directed, as is most frequently the case, against an exaggeration of the direct or reflex sensory-motor irritability of the nerves. We must now inquire what has been the action of this therapeutic agent upon the several affections for which it has been employed.

The great majority of elongations have been practised in cases of *neuralgia*, and particularly of *sciatic neuralgia*, and often the disappearance of the pain has been obtained; unfortunately, the proportion of definitive recoveries cannot be exactly known, because most of the cases are published too short a time after the operation. Thus, Walsham, studying forty-eight cases of neuralgia, reported as cured by elongation,¹ showed that nearly all had been published too soon. In fourteen of the cases, which he was able to trace, there were nine definitive recoveries and five relapses, following after intervals of from

¹ British Med. Journal, December, 1880.

five to eighteen months. Indeed, *traumatic neuralgias* are those which furnish the greatest number of successes.

Spasmodic affections of traumatic origin have also been treated by this procedure. It is known that the first intentional elongation was done by Nussbaum for a contracture consecutive to a contusion of the arm, and that his patient was cured, recovering even the lost sensibility of the dorsal skin of the forearm. In *tetanus*, elongation has given several successes, attributed to Vogt, Verneuil, Clark, Ratton (of Madras), and others, when the operation has not been done too late, and when all the nerves coming from the diseased region have been elongated. Recovery has also been obtained in some cases of *reflex epilepsy*, with well-marked aura. We have seen that, in Nussbaum's case, the sensibility returned as a result of the elongation. Blum has also obtained a recovery by employing this operation in a case of *traumatic paralysis* of sensation and motion in the forearm. This surgeon explains the result by the feebleness of the traction, which increases the conductivity of the nerves; but Laurie, of Lahore, and Bomfort, obtained analogous results in patients attacked with anæsthetic leprosy, by making very strong traction, and in some cases in spite of rupture of the nerves during the operation. These patients were not under observation long enough after the operation for it to be known if their recovery was definitive.

Elongation has also been proposed by Wecker¹ for certain affections of the *optic nerve*, but this author has as yet only performed it upon patients who were irrevocably blind, so as to study its influence upon pain, hallucinations, etc.; the operation did not have any annoying result. Elongation of the optic nerve has also been practised by Pamard, of Avignon.²

Certain *affections of the spinal cord* are also amenable to elongation. It has been recently quite often performed, especially in Germany, for the relief of the shooting pains of locomotor ataxia, and this operation, which has been practised upon the sciatic nerve in most of the cases, often makes the pain disappear, and ameliorates for a longer or shorter time the motor incoördination; this amelioration was maintained to the end, in a case of Langenbuch's, the patient dying three months after the operation in an attack of epilepsy. In a case of probable cancer of the spinal cord, successive elongation of both sciatic nerves caused a cessation of the intolerable pains, the first time for fifteen days, and the second time for five days.³ Nussbaum cured, by elongating the femoral and sciatic nerves, a patient who had suffered for eleven years from paraplegia with contracture, which had followed a fall upon the sacrum. Finally, elongation has been unsuccessfully tried for the cure of the lesions consecutive to infantile paralysis, and for those following cerebral hemorrhage.

In brief, the principal indication for elongation is the exaggeration of the direct or reflex sensory-motor irritability of the nerves, and, in particular, neuralgia. This operation should only be attempted when all other means of treatment have failed; but for the spinal nerves it should be preferred to either neurotomy or neurectomy. For the cranial nerves, we have said that it is necessary to be very reserved in its employment. Elongation is also indicated in traumatic contractures, tetanus, and reflex epilepsy, the surgeon being careful, in the latter cases, to elongate all the nerves which come from the focus of irritation, to interfere early, and to repeat the elongation a certain number of times, as advised by Johnston, if the first produces only a

¹ Wecker, *Annales d'Oculistique*, t. lxxxv. p. 134. 1881.

² *Société de Chirurgie*, 12 Avril, 1882.

³ Lamarre, *Contribution à l'étude de l'élongation des nerfs dans les affections médullaires*. *Revue de Chirurgie*, Juin, 1881.

temporary amelioration. Finally, this operation may be practised in ataxic patients, especially when the lightning pains are strongly marked.

The elongation of spinal nerves does not present any special gravity, and in none of the cases, already numerous, which have been thus far published, has any grave accident supervened in consequence of the tractions exerted upon the nerve-trunks, contrary to what might have been supposed from the cases of sudden death occurring during reduction of shoulder luxations, which are explained by the dragging on the brachial plexus. But it is evident that this operation, like all surgical interferences, exposes the patient to the accidents and the complications of wounds. In regard to the functional activity of the nerve, we have seen that persistent paralysis of motility has never been described as a result of elongation of these nerves. We know that it is not the same with the cranial nerves, and that the harmlessness of their elongation is much disputed. In either case the surgeon should be guarded in the employment of chloroform, since this operation, more than any other, perhaps, exposes to reflex syncope which may readily prove fatal.

OPERATIVE MANUAL.—Should *general anæsthesia* be employed? Debove and Gillette reject the employment of chloroform, fearing a sudden arrest of the heart by reflex excitement. Quinquaud rejects it in order to recognize the existence of anæsthesia, which demonstrates that the elongation has been sufficient. Chiene and Blum administer chloroform, and I have likewise used it. I have also employed *local anæsthesia* by means of the ether spray. The pain at the moment of elongation is excruciating, but transitory. Most frequently, general anæsthesia ought to be resorted to.

The operation of nerve-elongation or nerve-stretching includes *four stages*: (1) the incision and search for the nerve, (2) its isolation, (3) its elongation, and (4) finally its replacement, and the dressing of the wound.

(1) The first stage demands a complementary chapter of operative surgery, which has already been sketched by Vogt. As in the ligation of arteries, the *incision* should be as much as possible parallel to the course of the nerve, and its length should vary with the depth at which the nerve is situated. Blum advises choosing for the incision, as far as possible, the point nearest to the supposed place of origin of the symptoms, and the employment of Esmarch's bandage to facilitate the search for the nerve. When the region permits it, Gillette thinks it prudent to keep at a distance from the spinal cord. It is sufficient to say that the incision should be made at the point where the nerve trunk is most accessible; Esmarch's bandage is commonly useless, and should be removed at the moment of elongation.

The *search for the nerve* should be made with as little injury as possible to the surrounding tissues. Elongation of the sciatic nerve has often occasioned a suppurating wound, which I attribute to the fact that tractions are exercised upon the muscles; sometimes they are separated with the fingers, but it is better to make a clean-cut wound.

(2) The second stage of the operation may present some difficulties, if the nerve is inclosed in a tissue of new formation, cicatricial or otherwise. When once the nerve is exposed, it is *isolated* like the artery in a ligation, with the forceps or grooved director.

(3) The most important stage is now reached, *the elongation* itself, which may be done either with the finger, with the forceps or grooved director, or, finally, with a blunt hook such as I have had constructed, simply provided with a groove, concave in one direction and convex in the other, upon which the nerve lies, or carrying a dynamometer at the middle part of its shank, as in Gillette's instrument; but when it comes to be determined what force should be used in drawing upon the nerve, we are obliged to admit, with Trombetta,

that the indications given by surgeons upon this subject are vague. Taking the sciatic nerve, for example, of which the conditions of elongation are best determined, it is seen that Billroth advises only to lift it up with the finger; Mac Farlane and Nussbaum, to make progressive traction sufficiently strong to raise up the limb; Patruban, to stretch it forcibly, so that the roots may participate in the elongation; Chiene, to draw it from above downwards and from below upwards, forcibly enough to raise the limb from the operating table; Spence, to fix the foot, and draw the nerve until it yields with a sensation of resistance having been overcome; Robertson, to draw strongly until a certain degree of relaxation has been obtained; Langenbeek, to draw with great violence; Blum, finally, to make slight extension if the function of the nerve is diminished or suppressed, and a sudden and violent extension if the excitability of the nerve is increased. As regards other nerves, the confusion is still greater.

To permit an appreciation of the tractile force applicable to the elongation of each nerve, Trombetta and Gillette have undertaken experiments, of which I have already spoken. These authors think that one-third of the force necessary to cause a rupture of the nerve is sufficient for its therapeutic stretching, and they recommend the employment of the dynamometer in the elongation of nerves, in order to know exactly what is done, and not to exceed the limit that has been marked out. Scheving advises to take as a guide in elongation, the production of anæsthesia alone, and to make mild and progressive traction until complete anæsthesia in the territory of the elongated nerve has been obtained, a condition which seems necessary, as we have seen, in order to obtain a permanent recovery.

This procedure appears logical, but it ought not to prevent the employment of the dynamometer, which will, no doubt, after a time, permit the tracing of more precise rules for nerve-elongation.

Before exercising tractions upon the nerve-trunk, care must be taken to have the limb immovably fixed, in order that flexion of the articulations may not allow the nerve to make too great a loop, since a too wide-spread destruction of the connections of the nerve with its sheath might interfere both with the nutrition of the nerve and with the results of its elongation.

In what direction must the tractions on the nerve-trunk be made? The majority of surgeons draw perpendicularly to the axis of the nerve. Gillette advises to pass the hook of his extensor-dynamometer through an elliptical orifice of 4 centimetres ($1\frac{1}{2}$ inches), with rounded edges, scooped out in a thick piece of board; the nerve, in being elongated, is pressed against the edges of the board, which serve as pulleys for changing the direction of the force, the perpendicular traction being thus accompanied, according to the surgeon of Bicêtre, by traction in both the centripetal and the centrifugal direction. Other authors draw in both these directions, holding the nerve between their fingers. But, as was said in the physiological part of this article, tractions on the peripheral end act rather upon the motility, and centripetal tractions upon the sensibility; it is therefore useless, and may be injurious, to make tractions upon the peripheral end of the nerve.

(4) To finish the operation it remains only to replace the nerve in its normal situation and to dress the wound. There is here an urgent indication to seek for union by the first intention, in order to avoid the formation of a cicatricial tissue capable of compressing the nerve. Therefore, I think, Lister's dressing should be employed, just as all the precautions of the antiseptic method should be observed during the course of the operation. During the first days of the after-treatment the limb should be kept immovable. Bramwell has advised making movements when cicatrization begins, so as not to permit the nerve to form adhesions.

In conclusion, I must describe the mode of elongating the sciatic nerve proposed by Trombetta, in accordance with the experiments of Vogt, and based upon the exhaustion of the elasticity of this nerve in movements of forced flexion of the thigh. It consists simply in flexing the thigh upon the pelvis, beyond a right angle, while the leg is kept extended upon the thigh. This manipulation determines, according to this author, a lengthening of the sciatic nerve, as great as a man could produce by drawing with all his strength upon this nerve. In experiments upon the cadaver, I have ascertained that, in forced flexion of the thigh, the leg being extended, the sciatic nerve is strongly drawn over the posterior surface of the neck of femur, and is flattened at this point. Trombetta does not believe that his procedure is applicable to the brachial plexus, because the movements of the arm are naturally too extended to allow of their being much exaggerated.

This procedure avoids the inconveniences of a bloody operation, but it necessitates complete anaesthesia, and clinical facts in sufficient number to allow an appreciation of its therapeutic value, are yet wanting; finally, as it requires very great flexibility of the coxo-femoral articulation, it is often inapplicable.

III. NEUROTOMY AND NEURECTOMY.

The name *Neurotomy* is given to an operation which by a simple section interrupts the continuity of one or several nerves. *Neurectomy* is the resection of a more or less extended portion of a nerve-trunk.

These two operations have the same immediate results, and the circumstances by which they are indicated are very analogous; hence it is convenient to study them together, in order to avoid repetition, pointing out, by the way, the peculiarities proper to each.

HISTORY.—Without speaking of the old surgeons who treated neuralgias, consecutive to wounds of the head, by surrounding the wound with deep incisions, it was about the middle of the last century that nerve-section appears to have been devised and practised for the first time by Maréchal, for the cure of *tic douloureux* of the face. But the inadequacy of this operation was soon recognized, and at the end of the 18th century, André, a surgeon of Versailles, treated this affection by the application of caustic along the course of the nerve, in such a manner as to destroy it for a certain extent—a procedure more certain, said Boyer (1822), than the resection of a portion of the nerve-trunk, but which was, notwithstanding, but little employed, except as a last resort after the failure of resection, on account of the extent of the ravages which it determined. The abuse made of nerve-sections and their bad results, which are easily explained, since they were almost exclusively applied to facial neuralgias, the most obstinate of all, caused them to fall into complete discredit, from whence they were again raised, about 1852, the period at which Roux, in France, Laurenzi and Borelli, in Italy, Schuh and Patruban, in Austria, and Wagner, in Prussia, again brought them into honor. Subsequently they were extolled by Sédillot and Nélaton, in France, and by Weber, of Bonn; but it is Letiévant to whom is due the most complete study of them which has been made.

Apart from neuralgias, neurotomy has been tried in cases of functional spasm, and in a certain number of spasmodic affections; in tetanus, by Larrey; in certain cases of chorea which are kept up by peripheral lesions, by Borelli, of Turin, Andral, and Malden; in hysteria due to a lesion of the peripheral nerves; in hydrophobia; in paralysis agitans; and in the delirium from nerve-

wounds. Optico-ciliary neurotomy has also been extolled as a remedy for sympathetic ophthalmia, and section of the sciatic nerve for the cure of Arabian elephantiasis.

PHYSIOLOGY.—I shall say here only a few words upon the physiology of nerve-section, referring, for that which relates to this question, to what was said in regard to accidental sections of nerves, their cicatrization, and the trophic lesions by which they may be followed.

Let me repeat only, that the section of a mixed nerve is generally followed by *paralysis of motion and sensation* in a great part of its territory, but that these sensory-motor disturbances may be more or less completely and more or less rapidly lessened, in consequence, no doubt, of the return of nervous influence through the anastomoses of neighboring nerves. This substitution may be such that the section of an important nerve does not cause any functional disturbance, even momentarily, as has been seen in several instances, after isolated section of the median nerve in the forearm, without lesion of either the radial or the ulnar nerve. It is proper to insist here very particularly upon these facts, which, although rare, may explain to us the failure of operative nerve-sections in a certain number of cases. It must be added that, according to Letiévant and Tripier, the functional integrity after nerve-sections is more apparent than real; indeed, according to the former of these authors, the preservation of movements is due to the combined action of muscles innervated by uninjured nerve-trunks (*substituted motility*). As to the sensibility, it is preserved, by anastomoses, at the periphery of the zone of distribution of the nerve, but it is wanting in the remainder of its extent; the tactile sense alone is partly preserved on account of the shock which is communicated to the healthy papillæ of the neighborhood, mechanically, absolutely as if the finger were touched by that of another person; tactile impressions are, indeed, transmitted in both cases by contiguity, but the painful and thermic impressions are null.

At other times, on the contrary, the paralysis extends beyond the domain of the cut nerve—an event which is explained by the occurrence of vaso-motor disturbances.

After a certain period, about from four to six months, according to experiments upon animals, the phenomena of paralysis disappear by a process very different from that of which we have just spoken, by a true nervous regeneration, characterized by the appearance of nerve-fibres in the midst of the cicatricial tissue which unites the two ends of the divided nerve; this process has already been described on a preceding page.

When there is a loss of substance of the nerve, the immediate phenomena are the same, but the regeneration is more slowly effected; easily obtained after a resection of two centimetres ($\frac{3}{4}$ inch), according to Tripier, it becomes exceptional when the portion removed measures from four to six centimetres ($1\frac{1}{2}$ –2 inches). These figures are furnished by experiments upon animals and are not strictly applicable to man.

INDICATIONS AND RESULTS.—In speaking of the history of these operations, the several affections in which section and excision of nerve-trunks are employed have been briefly mentioned. It now remains for us to study in detail the indications and results of these operations in each of these affections.

Neuralgia constitutes the least disputed indication for nerve-section or excision, and these operations have been practised a much greater number of times for this affection than for all others together.

In the pages which treat of neuralgia in general, I insisted upon the importance and the difficulty of making a precise diagnosis as to the nature of the

neuralgia, according to the constitutional condition of the patient; as to its cause, peripheral or central (congestion, neuritis, ascending neuritis, compression); as to its exact seat, in the nerve-trunk, in the terminal branches, or in the central origin of the nerve. Finally, are we dealing with a reflex, or with an essential neuralgia?

From what has been said, then, three therapeutic indications are to be fulfilled:—

- (1) To combat the general constitutional state;
- (2) To combat the local nerve lesion; and
- (3) To combat the pain.

I insist upon the necessity of preceding all surgical interference by an appropriate general and local treatment, continued for a sufficiently long time.

But frequently the diagnosis is incomplete, and symptomatic treatment is employed in the endeavor to relieve the pain.

If the neuralgia is from a *peripheral cause*, the first indication is to endeavor to act upon this cause itself; if it escape our means of action, we must have recourse to neurotomy; but Tripier recommends, in such a case, to interrupt all communication with the nerve centres by multiple sections. The operative procedure will be relatively easy if the cause of the neuralgia still persist, but if it have disappeared, in consequence of previous treatment, for example, while allowing the pains to continue, some difficulty will be experienced in the operation. Tripier advises, in order to determine the seat of pain, to explore the nerve by pressure: If this, being applied over the nerve supposed to be affected, causes the pain to cease, it is to this nerve that we must direct our attention. If the pain does not cease, it may be inferred that the lesion either involves the recurrent fibres, or is centrally situated. In order to ascertain which are the recurrent fibres affected, pressure should be exerted upon the neighboring nerves.

In cases where the existence of a *central lesion* is probable, some advise to refrain from interference, while others still authorize the operation as a last resource, either in the hope of rendering the paroxysms less frequent by suppressing causes of peripheral irritation, or even in the endeavor to obtain a cure ultimately, through consecutive atrophy of the seat of the lesion. Vulpian and Dickinson have, in fact, observed, after a certain time, atrophy of the spinal cord at points corresponding to the origin of the nerves of amputated limbs.

If there is reason to fear that the case is one of *ascending neuritis* or *perineuritis*, neurotomy becomes necessary, or rather neurectomy above the lesion, taking care to examine the removed fragment, as advised by Brown-Séquard, in order to know if the nerve is still diseased at the point of section; and in case of failure, a new section must be made at a higher point of the same trunk. The difficulty of diagnosis in ascending neuritis accounts for many of the failures of neurotomy and neurectomy.

If the lesion is located in the *cutaneous ramifications* of the nerves, its dissemination and multiplicity of anastomoses may lead us to think that there is a central lesion, but there is almost always a more painful zone which seems the centre of irradiation, and the limits of which successive compression of the different nerve-branches will permit us to determine. Tripier advises, before resorting to nerve-section in these varieties of neuralgia, to treat them by applying very delicate caustic irons, so as to affect the entire thickness of the skin. If this treatment does not succeed, a *polyneurotomy* should be performed, cutting first those branches, compression upon which seems to cause a disappearance of the pain.

According to some authors, Vulpian among others, the possibility of a lesion occupying the terminal plexuses has not been demonstrated.

To sum up, section of nerves is especially indicated in neuralgias which are primarily peripheral, but may also succeed in some neuralgias of central origin; it may therefore be said, with Dennis, that its principal indication resides in the violence of the pains, and in their resistance to other means of treatment.

In regard to the *choice of operative procedure*, the opinions of authors differ according to their theory of the mode of relapse. Tripier, who believes that the pain returns rather through the ways of transmission which have been allowed to persist, than through the cicatrix of the nerve, extols simple division of all the painful branches, *simultaneous* or *successive polyneurotomy*, and he thinks neurectomy necessary only when it is wished to remove an altered portion of a nerve trunk. Letiéviant thinks that neurotomy, practised upon a single branch alone, should only be done if the neuralgia is traumatic; if it affects exclusively the sphere of distribution of a single nerve, or if it has begun thus very distinctly, and has only extended at a later period to the neighboring branches; if the paroxysm begins by a circumscribed pain of the nerve; if pressure upon the nerve which it is intended to cut diminishes or suppresses the paroxysm; and if there is no sign of central neuralgia: in all other cases he recommends simultaneous section of all the branches upon which there exist painful points (*points douloureux*). This author thinks, with Otto Weber and Virchow, that neurotomy is very probably sufficient to cure neuralgia when it is well applied. He recognizes only that neurectomy gives an additional security, and that it may be resorted to when the region permits this operation to be done without too much increasing the gravity of the prognosis, which is always more serious than that of a simple neurotomy. Such is not, however, the opinion of the great majority of surgeons of the present day, who see in the cicatricial union of the extremities of the divided nerve, the principal cause of relapse, and who consider neurectomy the best means of obviating its occurrence.

An operation recently proposed, the *elongation of nerves*, to which a special section of this article has been devoted, has been recommended for the cure of neuralgia as a substitute for the division of nerves, with or without resection. I may here add that, if elongation is perhaps preferable to section of nerves in neuralgias of the extremities, especially in the case of the mixed nerves, the motor function of which it preserves nearly intact, when, on the contrary, the cranial nerves are concerned—instead of elongation, which may act upon the nerve centres, exciting them, and causing either trophic disturbances, as in irritation of the branches of the trifacial, or arrest of the heart by reflex action—neurectomy is generally to be preferred, particularly for neuralgias of the fifth pair. For the facial nerve, however, if the case is one of painless spasm (*tic*) of the muscles of the face, it will be of advantage to employ moderate elongation, with crushing of the nerve, for example, between the blades of the forceps. Both reflex disturbance and permanent paralysis are thus avoided.

The surgical treatment, it is thus seen, should vary not only with each kind of neuralgia, but also with each kind of nerve, according as it is a spinal or cranial nerve, and, in the latter case, as it is a nerve of sensation or motion.

Sometimes section of the nerve is followed by a complete disappearance of the pain, at the very moment of operation—the recovery is instantaneous; but it is not unusual to see the pain continue for a certain time, and then gradually disappear. Again, the good effects of the operation may be much more slowly produced, the recovery being then attributed, as we have seen, to an atrophic process occurring in the nerve-centres as a result of the section of the nerve; but these cases must be received with hesitation, since they

may well be, at least in part, examples of spontaneous recovery, such as are observed now and then in neuralgias which have resisted all treatment.

In a great number of cases, after apparent recovery, more or less rapidly obtained, relapses occur. Thus, the statistics of 21 cases collected by Dennis show:—

6	relapses at the end of from 12 to 18 months.
3	“ “ “ 6 to 12 “
4	“ “ “ 1 to 6 “
4	“ before the end of 1 month.
4	cases without relapse, kept under observation from 1 to 2 months.

This shows how necessary it is to be cautious in affirming the radical cure of a neuralgia, and during how long a period a relapse may be feared. This may depend, (1) upon the neuralgia being due to a primary central lesion, or to a central lesion consecutive to a peripheral lesion, and persisting after the operation; (2) upon the existence of an ascending neuritis; (3) upon the neuralgia having its seat in the recurrent fibres; (4) upon the painful nerve not having been cut; (5) upon an adjoining painful nerve having been left intact; or (6), when the relapse is delayed, upon the cicatrization of the two ends of the nerve. It is to avoid this accident that many surgeons prefer neurectomy to neurotomy.

It seems, finally, that in certain cases it is not positively known how the operation acts, or why relapse occurs. We may suppose that neuralgia is more often of central origin than is generally believed; and we may recall the fact that those who have suffered amputation frequently complain of neuralgia in the part of the limb which has been removed.

Subsequent operations will vary according to the cause to which it is believed that the return of the pains should be attributed. Among the most obstinate neuralgias are those of the face; they are also those in which surgical treatment is the most difficult from an operative point of view.

As regards the exact proportion of successes and failures of nerve-section, such as might be deduced from a complete statistical record, it varies according to the nature and seat of the neuralgia, and a gross number representing the average of all the operations performed upon all the nerves would be of no value. It may be said, however, that neurotomy counts a great number of absolute or relative successes, the value of which is the greater, since this operation is employed only as a last resort for neuralgias which seem incurable by other means of treatment.

Neuralgic pains may be also observed in the zone of distribution of a purely motor nerve. These pains may be due either to a lesion of the recurrent fibres, which the neighboring sensory branches send to this motor nerve, or to an alteration of the motor nerve itself, indicated by spasmodic movements, which are the immediate cause of the pain. In the first case, the branches which send the recurrent fibres should be cut; and, in the second case, if the motor nerve is to be dealt with, elongation, with or without crushing, should be first tried; and afterwards, neurotomy or neurectomy, if necessary.

Section of motor or mixed nerves has, moreover, been practised for the cure of *obstinate functional spasms*. It has been done especially upon the spinal accessory and muscular cutaneous nerves. In these cases, I repeat, elongation should be preferred to neurotomy, except, as has already been pointed out, in the case of the cranial nerves. It may, however, be necessary to resort to neurotomy, as shown by a case of Annandale's, in which resection of the spinal accessory nerve was required for the relief of a functional spasmodic torticollis of the sterno-mastoid muscle, which had resisted elongation.¹

¹ Annandale, *Lancet*, vol. i. 1879, p. 555.

Traumatic tetanus has also been treated a certain number of times by nerve-section. All forms of this affection do not equally demand this operation; it should especially be practised when the contractions begin in the injured limb, and are accompanied by intense pain arising from the wound; when a nerve-lesion can be definitely recognized; when there is a tetanic aura at the beginning of each paroxysm; or when the presence of the symptom, pointed out by Wood, can be determined—the manifestation of pain in the wound at the moment that pressure is made upon one of the nerve-trunks which terminate in it. Even apart from these conditions, neurotomy should be performed, according to several authors, in all cases of tetanus accompanied by wounds. Under all circumstances, surgeons who recommend this operation insist upon the necessity of performing it early, before the secondary lesions of the nerve-centres are too extensive to yield to the general treatment which should always aid the neurotomy. The efficacy of this operation has been demonstrated by the instantaneous amelioration and rapid recovery which have followed in some cases. In respect to the choice of operation, there is no question of neurectomy, since the interruption of the nervous current should be only temporary; the choice is between simple and total neurotomy. The latter, true “nervous amputation of the limb,” as it is called by Tripier, who recommends it as an exclusive method in the treatment of tetanus, has the serious inconvenience of leaving as a result a nearly useless limb, although its advocate affirms that every trace of paralysis should disappear at the end of about six months; it is also objected to this operation, that it multiplies the causes of irritation. Letiévand, nevertheless, believes that it may be properly resorted to when no special sign points to any particular nerve. As was said in studying the treatment of tetanus, recent cases seem to demonstrate that nerve-elongation is sufficient to arrest the symptoms, when it is employed in time; a few more favorable results, and it should be substituted for neurotomy, particularly since, even when combined with crushing, as is done by Verneuil, it is followed by a more certain and more rapid re-establishment of the nervous functions—a fact which should encourage us to resort to the operation freely and in good time, a condition essential to success in the treatment of tetanus.

Cases of *epileptiform convulsions* consecutive to traumatisms, cured by neurotomy or neurectomy, are sufficiently rare and sufficiently obscure for it to be impossible, as yet, to form any absolute conclusion in regard to them; it can only be said, that it is rational to think that these operations may be useful in certain cases. The same must be said in relation to *idiopathic epilepsy*, notwithstanding the numerous and interesting experiments of Brown-Séquard upon animals, from which Tripier thinks himself justified in concluding that neurotomy may and should be applied in all cases in which there exists an epileptic zone. This, however, is going too fast, and these experiments of the laboratory require confirmation from clinical observations.

It must suffice to mention the other affections to which Brown-Séquard believes neurotomy applicable in certain cases: these are *hysteria* from lesion of peripheral nerves—very difficult to diagnose—*hydrophobia*, *chorea*, *paralysis agitans*, and *delirium* from nerve-wounds. Nerve-section has also been practised in cases of *elephantiasis arabum*, so as to utilize the atrophy consecutive to the suppression of innervation. T. G. Morton has published the case of a negro, thirty-four years old, otherwise in good health, whom he treated by resection of one and a half inches from the great sciatic nerve, after unsuccessful ligation of the femoral artery and compression of the limb. This man had suffered for fourteen years with elephantiasis, limited to the right leg and thigh. Two months after the operation the limb had already

considerably diminished in size, and the scaly epidermis had desquamated, leaving a soft and pliable skin. Sensation had returned in almost all the territory of the cut nerve, and the skin did not present any tendency to ulceration.

Finally, section of all the nerves of the orbit (*optico-ciliary neurotomy*) has been extolled as a remedy for sympathetic ophthalmia. The efficacy of this operation is yet contested: while some, indeed, think it sufficient to arrest the development of symptoms as well as is done by enucleation, most oculists consider it only as a preventive operation, which should be done before the appearance of sympathetic ophthalmia, but to which it is not prudent to trust when once that affection is declared.

If we now endeavor to sum up the respective indications of section and resection of nerves, we shall see that neurotomy should be employed for tetanus and convulsive neuroses—affections which necessitate only a temporary interruption of the conductivity of the nerve—while neurectomy is to be preferred when it is desired to definitively abolish this conductivity, either to cure neuralgias or certain functional spasms, or in order to determine a permanent modification of the nutrition of tissues, as Morton did in the case of elephantiasis which has been quoted.

The consequences of neurotomy and neurectomy are usually very simple as regards the wound of operation, and union by the first intention will be most often obtained if the antiseptic method be employed; it is, moreover, especially desirable in an operation of this kind, in order to avoid the formation of a fibrous and retractile cicatricial tissue, capable of compressing the extremities of the nerves at any given moment, and of giving rise to new symptoms.

OPERATIVE MANUAL.—I need only mention, as a matter of historical interest, the *subcutaneous section* of nerves, which, at the present day, is almost universally condemned, and the few and questionable advantages of which are largely counterbalanced by the uncertainty of its result, which is usually incomplete.

It is then by means of an open wound that *neurotomy* must be done, with observance of antiseptic precautions, suited to render the operation as harmless as possible. The search for the nerve is made as in ligations of arteries, by taking as guides, lines of reference, muscular and osseous prominences, and the anatomical relations of the nerve-trunks (accompanying arteries, etc.). Further assistance may be gained, moreover, in the living subject, if the patient has not been rendered insensible, by excitations applied to the nerve, and by pressure exerted along its course. The rules suited for securing the discovery of each nerve-trunk in particular, have been traced by Letiévaut in his *Traité des Sections Nerveuses*.

The operation includes the incision, the search for and isolation of the nerve, and finally its section. The latter is done with the bistoury or with scissors, which Letiévaut prefers, since the knife, he says, drags upon the nerve-trunk. When multiple sections are desired, as recommended by Tripiér, it is necessary to dispose them in such a way as to interrupt all communication with the diseased part while causing the least possible disturbance; this is done by carefully studying the painful points (*points douloureux*), and by having an exact knowledge of the distribution and anastomoses of the different nerves. However, except in tetanus, where this author extols total neurotomy at the beginning of the disease, nothing requires all these sections to be made at the same time, and sometimes it is advantageous, on the contrary, to divide them between several operations (*successive polyneurotomy*).

Neurectomy requires a larger incision and more extended isolation of the nerve. The difficulties presented by the application of this operation to the nerves of the face can be readily understood, since they most often must be sought for in the osseous canals which contain them, in proximity to important organs. It is in these cases that the choice of operative procedure presents a real importance; there exist, moreover, several methods for each of the nerve-trunks which it is necessary to resect.

The length of the piece of nerve which it is desirable to retrench, has not yet been exactly determined; as much must be removed as is possible without too seriously complicating the operation. It may be said that reunion of the two ends is exceptional after a resection of five centimetres (two inches). Some surgeons, in order more surely to avoid a relapse, followed the section of the nerve by avulsion, as extensive as possible, of its peripheral end.

In order to avoid cicatricial union of the two cut extremities, the older surgeons devised various procedures, all of which have fallen into disuse. Such were the bending back in loops of both ends of the nerve, or the interposition of a piece of flesh, as proposed by Malgaigne, and cauterization, as extolled by Boyer. The latter does not give any more security against relapse than does resection, and it, moreover, exposes the patient to accidents: it has been followed by tetanus, as in Frère's case, reported by Tillaux.

This study of neurotomy and neurectomy may be appropriately terminated with the relation of an interesting case, published by Drs. H. B. Sands and E. C. Séguin:—

A man, eighteen years old, was violently thrown backwards more than twenty feet, by the recoil of a cannon, on July 4, 1871. He lost consciousness for five minutes, receiving a contused wound of the right thumb, and a fracture of both bones of the forearm. At this moment, his right hand, he said, was as if it were dead. Three weeks afterwards, a violent neuralgia occurred along the course of the injured ulnar nerve, and in the little and ring fingers.

August 14. Drs. Sands and Séguin ascertained that the patient could not execute any voluntary movement, that sensation was abolished from the extremities of the fingers to the upper part of the arm, and that above the zone of anæsthesia there was hyperalgesia in the scapular and clavicular regions.

In view of the subjective symptoms complained of by the patient, these physicians were led to believe that there was an irritation of the nerve-trunks, produced by the fracture of the bones of the forearm, the fragments of which, no doubt, compressed or imprisoned the ulnar nerve. On the other hand, the paralysis and anæsthesia were too extended for the lesion not to reach much higher than the fracture, and, as a consequence, any operation practised at the seat of the solution of continuity, or below it, would have been useless. Dr. Séguin, believing that there was an ascending neuritis, recommended the application of powerful revulsives above and below the clavicle.

August 28. The pains were still more severe. Dr. Hamilton thought that there was a rupture of the nerve-trunks in the axillary region, and proposed amputation of the arm, which was performed on August 29. The median, ulnar, and musculo-cutaneous nerves were in a state of complete degeneration. They were neither compressed by the fragments of the broken bones, nor inclosed in the space between them. Temporary relief followed, but the pains returned.

Dr. Séguin proposed resection of the nerves which form the brachial plexus as close as possible to their points of emergence from the intervertebral foramina.

November 5. Neurectomy was performed by Dr. Sands, in the region of the neck. The right fifth, sixth, and seventh cervical nerves were excised, as well as several other nerves; all the fragments removed showed evidences of neuritis, with thickening of the neurilemma and granular degeneration of the fibres.

Marked benefit was experienced from this operation, but the patient, kept under observation for a year, still had obstinate pains occasionally.

This case is interesting, both on account of the difficulty of diagnosis and because of the different operations which were performed, the last—*neurectomy of the branches of origin of the brachial plexus*—being then practised for the first time.

The authors thought, with reason, that there had probably been produced, at the moment of the accident, a complete solution of continuity of all the nerves which were distributed to the lower part of the upper extremity.

[ADDITIONAL REMARKS ON THE PATHOLOGY OF TETANUS.]

The *humoral* theory of the pathogeny of tetanus has recently attracted a good deal of attention, and reasons have been adduced for considering it a contagious disease, and for believing that it may be transmitted from the horse. It is supposed by Flügge to be caused by a bacillus which is found in many kinds of ordinary earth, and the upturning and disturbance of the ground in battle, is, according to this view, to be regarded as the exciting cause of tetanus among the wounded, rather than the exposure to cold to which the prevalence of the disease has been ordinarily attributed. The doctrine, however, that cold also may exercise a causative influence in this respect, is sustained by the observation of Wagner that tetanus is particularly apt to occur in cases of frost-bite. The contagious character of tetanus is sustained by facts which are within the knowledge of most surgeons, the disease being often seen in small localized epidemics, in particular wards of hospitals, and within limited periods of time. Thus, in my own experience, at least twice, in different hospitals, the admission and death of a patient suffering from acute tetanus has been followed by the occurrence of a second case in a patient occupying a neighboring bed. Several very remarkable series of cases illustrating the contagiousness of tetanus have been communicated to the *Société de Chirurgie* of Paris by M. Larger, and the same surgeon has adduced facts confirming the theory maintained by Prof. Verneuil, of the equine origin of the disease. M. Larger's conclusions, in a somewhat abridged form, are as follows: (1) That tetanus is an *epidemic* affection; (2) that it may become *endemic* at any season, in a village, or even in a stable or farm-yard, but not in a hospital-ward—a circumstance which inclines him to the opinion that the agent which produces the disease resides in the soil, where it finds its conditions of development and reproduction; and (3) that it is contagious. The negative results of the inoculations practised by Arloing and Tripier show merely that the microbe does not exist in the blood or pus of a tetanic patient, but do not prove its absence from the structures of the nervous system, where Larger believes that it will eventually be discovered.

In the discussion which followed M. Larger's first communication, M. Terrier pointed out, in opposition to his views, that inoculation with the nerve-matter of tetanic patients had been actually practised by Nocard, but with entirely negative results, and maintained that, in spite of the claim of Drs. Brown and Curtis to have discovered microbacteria in the blood of patients affected with tetanus,¹ the existence of a microbe peculiar to this disease was disproved by the experiments in question. In the discussion

[¹ Microbes have been found by Doyen in the blood of tetanic patients, and also in the brain and liver.]

upon M. Larger's second communication, facts strongly tending to show not only the contagiousness but also the equine origin of tetanus were brought forward by MM. Verneuil and Kirnisson, and the former declared that clinical observation had demonstrated that tetanus was transmitted from horse to horse, from horse to man, and from man to man, and that though the microbe which caused the disease was as yet undiscovered, the contagiousness of the malady could no longer be doubted.]

INJURIES OF THE JOINTS.

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INJURIES of the joints derive their great importance mainly from two circumstances, both of them mechanical in their nature:—

(1) The complexity of their structure, which renders a slight displacement of parts, or adhesion of surfaces, fatal to their perfect mechanical action ;

(2) The presence of the synovial cavity, which on exposure to the air receives septic germs, and becomes a reservoir filled with putrid secretions, which both poison the whole system, and, locally, cause caries of the bones.

The great modern improvements in this branch of surgery are nearly all related to these two conditions, and derive their value from their power over them.

In discussing the subject of this article, I shall divide it according to the nature of the injuries, first taking up the important topic of dislocations.

DISLOCATIONS.

A *dislocation*, or *luxation*, is a displacement of the articular surfaces of a joint from their normal, relative position. If these surfaces are entirely separated, the dislocation is termed *complete*. Where partial separation occurs, it is termed *incomplete*. If the joint cavity has not been laid open to the external air, the dislocation is *simple*. If it is thus opened, the dislocation is *compound*.

CAUSES OF DISLOCATION.—The chief, *predisposing causes* of dislocations of the joints are laxity of the *capsular ligament*, or rents made in it by previous injury, and imperfections in the margins or other *bony and cartilaginous parts of the joints* from disease or former accidents. The normal structure of certain articulations predisposes them more to dislocation than others. Thus the shallow cup, and loose ligaments required to allow wide movements of the shoulder, render that articulation specially liable to the accident.

Malgaigne classified 603 cases of dislocation, with the following numbers for each part, viz.:—

Shoulder	370	Thumb	20	Fingers	7
Elbow	45	Wrist	16	Vertebræ	4
Clavicle	42	Knee	9	Metatarsus	2
Hip	40	Radius	7	Patella	2
Ankle	31	Jaw	7	Pelvis	1

Among the predisposing causes, *age* has some influence. Dislocations are most frequent in middle life, not only because at that period the necessities of active life subject men more frequently to risk of external violence, but also because the bones of children and old men are more prone to break than to be put out of joint.

An unnatural degree of *relaxation of joint-structures* is a very frequent, predisposing cause of luxation. This looseness of the capsules may be congenital, or may be developed by systematic stretching of a gymnastic sort. Strangely enough, the power of voluntary displacement of all the principal joints can be attained by long practice. Persons who have acquired this abnormal proficiency have travelled from city to city in the last few years, making a subsistence from the fees of medical students before whom they have exhibited the wonderful malpositions which they could produce at will in the joints of all the limbs.

The most usual *exciting cause* of dislocation is external violence; but in a few instances the luxation is the result of subjective influence, viz.: muscular tension, or the destruction of the boundaries of the joint by disease, or both causes acting in concert. Where great external violence is applied to a joint, the direction of the force will have much to do in determining whether the injury shall be a dislocation or a fracture. The strength of the capsular ligament is least on those sides of a joint where there is least frequent pressure; hence, if the force happens to drive the head of the bone in that direction, a dislocation will ensue, but if the movement is towards the places best guarded, the bone will generally give way instead of the ligament, as, for instance, in the hip joint, where dislocation in the direction of the thick \mathbf{Y} ligament is seldom or never seen.

SYMPTOMS.—The *rational symptoms* of dislocation usually are not such as to be of any value in differential diagnosis. The *local symptoms* only are of importance. *Deformity* due to three causes is found to exist whenever a bone is out of joint. (1) Flattening or depression of the region from which the articular extremity has been removed. (2) Prominence, from its presence in a new place. (3) Unnatural position of the limb or other member, from the resistance of the ligaments or muscles to the unusual traction. The member may be unnaturally lengthened, shortened, flexed, extended, rotated, adducted, or abducted.

Mobility as a rule is impaired, but is not totally abolished. The limb offers to the hand moving it a species of elastic resistance, wholly different from the unrestrained, natural sweep of the member in its normal condition.

Sometimes in causing the misplaced head of the bone to move across the torn fibres of ligaments which lie about it, a sensation is conveyed to the hand of the surgeon, faintly resembling *crepitus*. This differs so decidedly from the hard grating perceived by the hand or the ear in cases of fracture, that it seldom leads to difficulty of diagnosis.

In most cases of dislocation, rupture of the capsule takes place, but in a few instances ligamentous relaxation is so great that entire separation of the joint surfaces is found without rending of the fibrous connections. The synovial membrane seldom escapes more or less injury when a joint has suffered displacement. Inflammation from this cause may be of such severity that partial adhesion of the opposing surfaces, or even complete ankylosis, is a result.

When a dislocation is not reduced, various structural changes take place in the vicinity. The old socket sometimes becomes in a great measure filled up and obliterated, while in other instances it persists for a surprising length

of time, in consequence of the synovial membrane and secretions preventing the intrusion of new tissue into the cavity.

The pressure of the head of the bone at a new point causes fibrous effusion to take place around it, thus limiting and confining it in its movements, and so an imperfect articular cavity is produced in its new locality. Sometimes this is lubricated by a fluid resembling synovia, and answers a very useful purpose as a substitute for the original joint.

In old dislocations, adjacent organs often become modified in length and position to accommodate themselves to the new conditions. Important vessels may become so entangled in adhesions about a dislocated bone as to be torn by any efforts at replacement.

PROGNOSIS.—If a dislocation be reduced, there is usually almost complete restoration of the original usefulness of the joint. Yet several months or even years may elapse before the whole effects of the injury pass away, and in many cases absolute restoration is not secured. Occasionally, the inflammation resulting from the accident causes adhesions of such extent between the opposing surfaces that complete ankylosis is the result.

When a dislocation remains unreduced, of course the imperfection of the limb is far greater, although sometimes considerable mobility may remain. Compound dislocations involve great risk of suppuration and caries, often raising serious question as to whether amputation would not be more advisable than to run the dangers of a suppurative synovitis.

TREATMENT OF DISLOCATIONS.—The indications to be met in the treatment of dislocations, are (1) the reduction of the dislocation, (2) the prevention of inflammation, and (3) the restoration of usefulness to the joint.

Reduction—the chief indication—should in all cases be accomplished as early as circumstances will permit. The changes induced by inflammation, and by the welding together of the soft parts in their new relations, combine to increase the difficulty of reduction in proportion to the amount of delay in attempting it. If, therefore, there should be any doubt about the diagnosis after an ordinary examination, anaesthetics should be promptly and unhesitatingly employed to facilitate the investigation. The same agents assist greatly in reduction by causing muscular relaxation.

The older surgeons, on the supposition that the chief obstacle to reduction lay in the tension of the muscles, freely resorted to venesection, nauseants, and hot baths, as adjuvants to reduction. The progress of investigation has shown, however, that muscular resistance is only a small part of the force to be overcome. The chief obstacle to replacement is found to be the untorn portion of the capsular ligament, and we can readily see that nauseants and depressants can have no influence upon this kind of tissue.

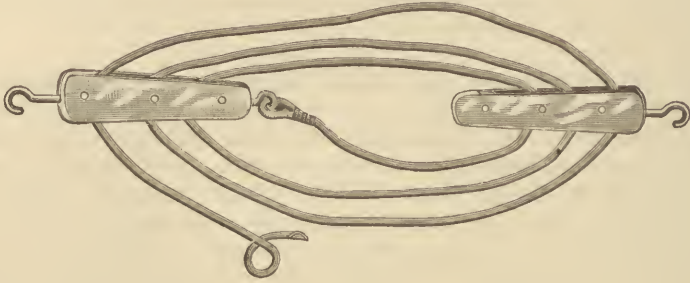
Still, though venesection and tartar emetic have become completely obsolete as aids in reduction, it is true that the muscles have some influence. To disarm their resistance, no agents are as effectual as chloroform and ether, as they not only produce relaxation, but also withhold the patient's mind and will from interfering with necessary manipulations. The abolition of pain also renders the surgeon's task more easy and more certain of perfect execution, even where there is no obscurity in diagnosis to require the anaesthetic.

The surgeon's hand is the principal means of force employed in reducing dislocations. Reductions made without the employment of mechanical apparatus are termed *reductions by manipulation*. When greater force is needed than can in this way be obtained, the coöperating hands of assistants frequently will give the requisite power. When, for any reasons, these are insufficient or inconvenient, mechanical contrivances are resorted to. The force employed

to draw the dislocated member in a direction away from the body, is called the *extending force*. As this force is often so great that it would drag the patient's body into a faulty position, a counteracting power is necessary to fix the body by acting in a contrary direction. This is denominated the *counter-extending force*.

The form of apparatus formerly most used to increase the power of extension, was the rope and pulley. The mechanics of this every-day contrivance

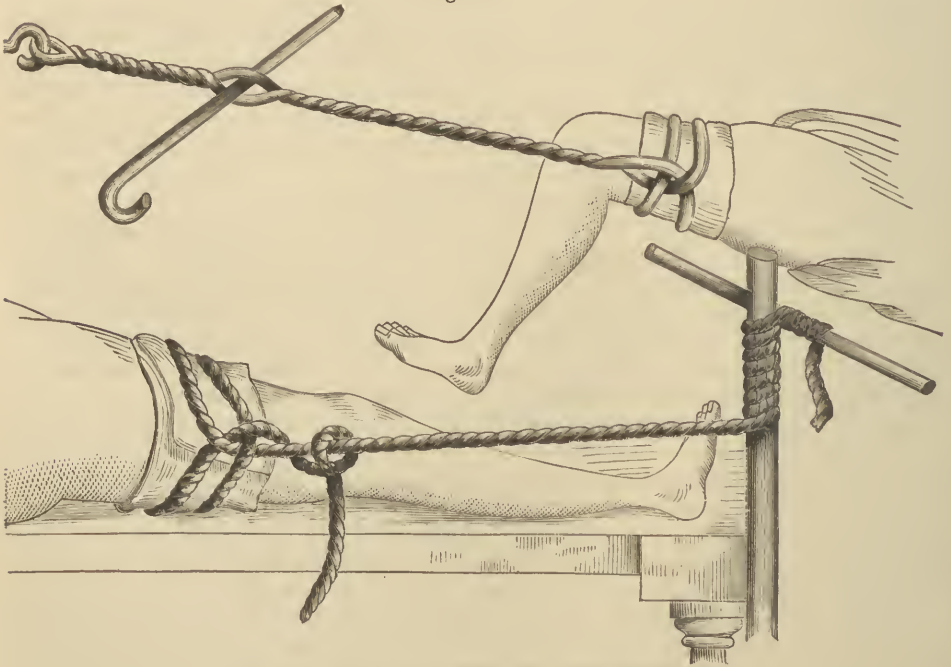
Fig. 553.



Triple pulley.

for multiplying power are too well understood to need explanation. Pulleys for surgical use do not differ from those made for other purposes. The common two- and three-wheeled blocks of ship-chandlers are equally efficient, though less elegantly constructed.

Fig. 554.



Spanish windlass and Spanish capstan, with clove-hitch.

When pulleys are not at command, extemporaneous contrivances can be made to answer a good purpose as means of powerful extension. A con-

trivance called by sailors the Spanish windlass, is made by twisting with a crossbar a number of cords, attached to the extending band at one end, and to some fixed object at the other. As the crossbar is swept around continuously in one direction, the torsion of the bundle contracts its length with irresistible power for a short distance.

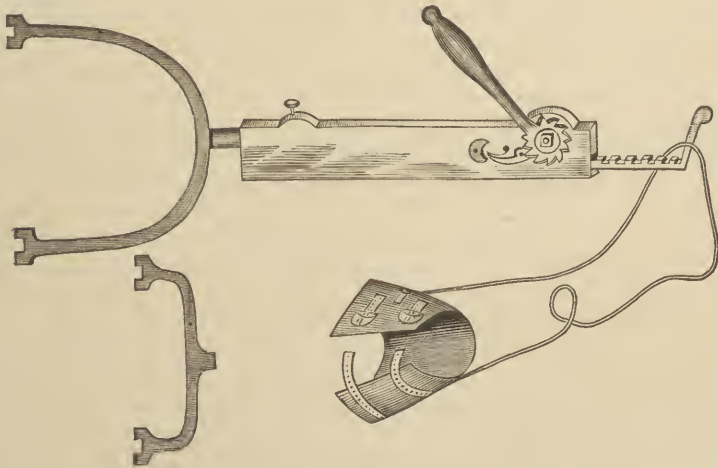
The power thus obtained is dangerously great, and, at the same time, the limits of motion are inconveniently small. The contrivance is much inferior to one used by the author in such cases, and called by some sailors the Spanish capstan, although it too is termed the Spanish windlass by many. The contrivance is more easily extemporized than the one commonly recommended by surgical writers, and is always preferred by sailors for simple increase of power within moderate limits.

To set up this apparatus, let the extending line be carried around a strong, movable stick or rail of any kind, and fastened by one or two turns to a crossbar, placed at right angles. For this purpose boatmen often use two oars. The handle of a broom, with a cane or rule for a crossbar, will furnish enough power for reducing dislocations. This strong bar is placed so as to rest across a doorway or window, the foot of the patient's bed, or some firm support, and the opposite end of the cord is attached to the limb, and extension to any amount is obtained simply by sweeping the crossbar around the other, winding up the cord upon it as a capstan winds up a cable.

The Spanish capstan is by far the best of all extemporaneous methods of multiplying the extending power. It gives any required amount of tractile force, it is easily prepared, and, instead of being limited to the few inches of shortening obtainable by twisting the cords of the Spanish windlass, it will haul in forty feet of line, if desired, as readily as one. In this method, also, the assistant whose hand turns the cross-stick readily estimates the amount of force, and avoids the unwitting application of a dangerous amount of tension.

Jarvis's Adjuster.—A very valuable instrument for all purposes of making extension was known to surgeons of the past generation as Jarvis's adjuster.

Fig. 555.



Jarvis's adjuster.

Although not at the present day manufactured and sold, on account of the general neglect into which it has fallen with the profession, this is still, for a certain percentage of cases, the most efficient means of treatment we have at command, and one unaccountably neglected by modern surgeons. For the

reduction of all dislocations requiring more force than the unaided hand can bring to bear, the adjuster is equally efficient, taking the place of pulleys, etc. But it is particularly helpful in cases where it is desirable to make use of powerful extension combined with manipulation. Fixed extension, by ropes and counter-bands, holds the patient firmly in a single position, and the direction of the extending force can be but little altered. The Jarvis adjuster, on the other hand, is attached entirely to the patient's body, and when it has been set in extension, the force of the pull and counter-pull is exerted independently of any outside support. The patient may be placed in any position deemed convenient, and may be moved about without interrupting the extension. The direction of the motion being in a straight line peripherally, in the axis of the limb, from the region of the joint as a centre, the desired extension may be had whether the limb be bent or straight; so that, while with fixed extension only one motion (rotation) can be employed, with the adjuster in place, flexion, adduction, and abduction, can be called in to assist extension. Improved methods of manipulation, together with the expense of the instrument, perhaps, have caused it to become nearly obsolete. It is no longer sold by dealers. Still, it remains true, that by its use a certain number of cases may be successfully reduced, which would resist all efforts with the pulleys, or by manipulation.

Whatever the source of power may be, the extending line or cord must be attached to the limb in such a way as not to cause injury to the parts subjected to its pressure. A secure hold is obtained by wrapping a damp towel about the limb at the place where the attachment is made. Over the towel, the band of linen or other strong material is placed in what sailors call the clove hitch (see Fig. 554). With Jarvis's adjuster, strong bands of linen webbing are buckled around the limb and furnished with loops for the attachment of the cords. Some surgeons make use of broad bands of heavy harness leather, held firmly about the limb by a row of buckles in much the same manner.

The extending apparatus of whatever sort, except the adjuster, requires some firm attachment from which the force may act. The post or foot-board of the patient's bed may sometimes be made use of. A crossbar set in a doorway or window will sometimes be the only means to receive solid support. Screw-hooks and rings, such as are used for this purpose, should be of large size, and so placed as to take hold firmly of the joists, and not merely the weaker parts of the wall. Carelessness in this regard may cause accidents.

Counter-extension may be made by the hands of assistants, or solely by the weight of the patient's body, when no great force is employed in reduction, and particularly if extension is made in an upward direction. Usually the body will have to be fixed when any mechanical aids are required to assist extension. Folded sheets, or other strong cloths, are to be passed about such parts as we wish to hold firmly in place. The ends of these bands of cloth are held in the hands of assistants, or are tied to some firm object.

The position in which a limb should be placed for reduction by extension is that which tends most effectually to relax (1) the untorn portion of the capsular ligament, and (2) the muscles whose resistance is to be overcome. In quality, the force should never be sudden or jerking (except in certain special conditions), but uniform and persistent, gradually increasing and overcoming whatever part of the resisting power may be due to muscular tension, and stretching or tearing, just to the requisite degree, but no further, the ligamentous bands which furnish the remainder of the opposition. Soft tissues yield gradually to this persistent extension, though they would be destroyed by sufficient traction to overcome their resistance if it were suddenly applied.

Extension may sometimes be accompanied by rotary and rocking movements of the displaced bone, so made as to favor its disentanglement from resisting bands, and especially to allow its insinuation into the lacerated opening or slit of the capsular ligament, made by the head of the bone in its escape from its normal position.

When the effort at reduction has been successful, the bone is often felt to slip into place suddenly, and sometimes with a dull sound, most inappropriately called in surgical terminology the "snap" of reduction. Under anæsthesia the sound is much less distinct, on account of the muscular relaxation thus obtained.

In the reduction of an old dislocation, the head of the bone makes its way so slowly into the socket as usually to cause no jerk or perceptible sound to indicate the precise time when it has arrived in its proper position.

After Care.—When reduction has been effected, the injured limb must be kept in such a posture, and so dressed and treated, as (1) to provide against the liability of the bone again to become luxated, (2) to combat the tendency to inflammation, and (3) to restore the mobility of the joint. The importance of these indications is in the order given.

Liability to redisplacement in simple uncomplicated luxations is great in a few joints, but not in the majority. It can almost certainly be controlled by care in keeping the parts at rest. Rest is the most important factor also in the prevention of excessive inflammation, and in the promotion of repair in the lacerated joint. Splints and retaining bands of various sorts, with or without permanent extension, are made use of to secure repose, and thus to prevent inflammation as well as displacement.

Both local and constitutional antiphlogistics are to be vigorously employed when necessary. Threatening synovitis, or such a degree of infiltration and swelling of the soft parts as would seem to endanger the future power of the joint, would form indications for their use. Synovitis occurring as a sequel of dislocation is to be treated in the same manner as when produced by any other traumatic cause. To restore the function of the joint, movements should be practised early in some cases, but very cautiously in others.

Natural Bone Setters.—The power or gift of "setting" dislocated bones, popularly supposed to reside in certain persons called "natural bone setters," is not usually exercised upon real dislocations. The sequelæ of various injuries in the form of false ankyloses, are by them falsely pronounced dislocations, and treated by various wrenches and jerks hereafter to be described.

SPECIAL DISLOCATIONS.

DISLOCATION OF THE LOWER JAW.

This accident is rare, constituting only about one per cent. of all dislocations. It may occur on one or both sides.

CAUSES.—The causes are external violence, as a blow or a fall, or muscular action. This may occur at a moment when the mouth is widely opened, as in the act of laughing, gaping, or vomiting. I have seen one case in which the bilateral dislocation was produced by the muscular action of vomiting after

a lobelia emetic. Sir Astley Cooper relates an instance in which dislocation was caused by the thrusting a large apple into a child's mouth. The muscles of mastication, like those elsewhere in the body, when brought into extreme contraction, sometimes become affected by a spasmodic shortening or "cramp" which the will is unable to control. The arrangement of muscles in the jaw is such that a powerful contraction at full extension, tends to force the heads of the bone forward, and may rupture the capsule. The internal pterygoid, inserted near the angle upon its deep surface, becomes a sort of fulcrum when the jaw is widely opened. The various depressor muscles at the symphysis act therefore upon the longer arm of a lever forcing the condyles with great power against the anterior wall of the capsules, and tending to break through them. The external pterygoids assist directly in pulling the condyles forward.

All these muscles are affected by the motor branch of the fifth pair, and when from reflex or other impression they act simultaneously, their power is very great. The condyles, which in the extended position are poised somewhat upon the summits of the articular eminences, are, by the spasmodic action referred to, made to spring forward in front of these prominences, and are immediately drawn upward under the zygomatic arches by the temporal and masseter muscles. The inter-articular cartilages still remain attached to the condyles in most cases.

SYMPTOMS.—When both condyles are dislocated, the jaw remains open so that the teeth cannot be brought together, though the lips sometimes can be closed, the jaw itself remaining nearly immovable; a vacuity may be felt at the usual location of the condyles near the ear.

The amount of pain is variable.

In case the dislocation is unilateral, the opening of the mouth is less conspicuous, and the chin is thrown around, away from the dislocated side, causing the middle line of the incisor teeth of the lower jaw to be shifted considerably to the right or left of that of the upper incisors.

A sort of partial dislocation of the jaw is occasionally met with in persons with unusually lax ligaments, the head of the bone having slipped forward upon, but not beyond, the articular eminence, so as not to come completely in front of the root of the zygoma. A slight movement will cause the bone to return with a snap to its natural seat.

If the dislocation be not reduced, the movements of the jaw remain permanently impaired. Yet the patient often acquires considerably more power of moving the bone in its new and false position than one might have imagined possible.

Dislocations of the jaw of long standing have in some instances been reduced. Stromeyer, after twenty-five days had elapsed, succeeded in accomplishing reduction. Donovan, after twenty-eight, and Pollock, after one hundred and twenty days, were similarly successful.

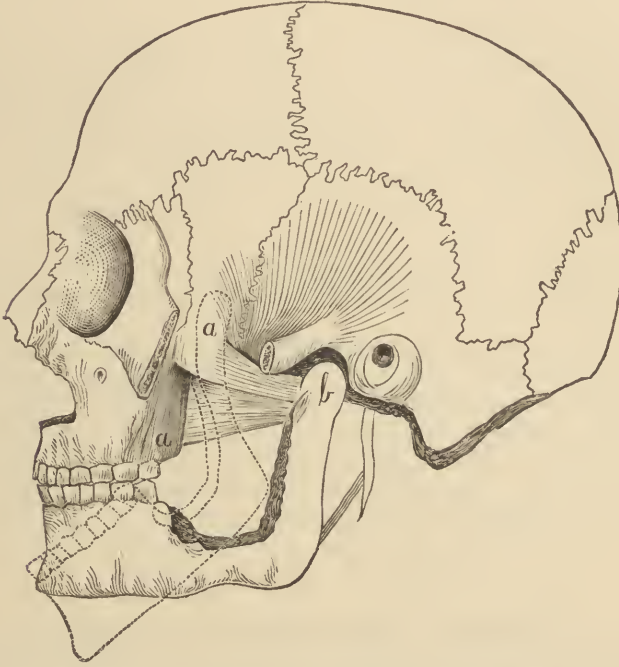
TREATMENT.—Usually reduction is not very difficult, and it may safely be attempted even when the dislocation is of long standing. The necessary steps in the manipulation are, (1) To depress the condyles below the level of the articular eminences, and (2) To force them directly backward to their normal positions, just behind these eminences.

To accomplish reduction most readily, the patient must be placed in a chair, while the operator takes his stand directly in front, having his thumbs wrapped in napkins to protect them against the spasmodic closure of the patient's jaws.

The surgeon places one thumb upon each posterior molar tooth of the lower jaw, while with his fingers he is ready to press upon the anterior por-

tion beneath the chin. He now presses strongly downwards with his thumbs, and at the same moment uses his fingers to push the chin in an upward direction. In this manipulation the thumbs become the fulcrum of a lever, the power being applied by the fingers at the chin, and the work done being

Fig. 556.



Showing action of external pterygoid muscle (*a b d*) in dislocation of lower jaw; the dotted line shows the position of the bone when displaced.

represented by the depressing of the condyles. When the condyles have been forced down below the level of the articulation, the first step of the operation is finished, and the surgeon then pushes the bone directly backward, when the reduction usually will be found complete. In difficult cases, corks may be substituted for the surgeon's thumbs between the back teeth.

DISLOCATIONS OF THE RIBS.

DISLOCATION OF THE RIBS FROM THE VERTEBRÆ.—Many of the older authors have described instances of dislocation of the ribs from their articulations with the spinal column, but modern criticism has so far impaired the value of this testimony as to render it doubtful whether any of the recorded cases were correctly diagnosed, except one mentioned by Bransby Cooper, who found upon *post-mortem* examination an ancient dislocation of the seventh rib. During the patient's life, we have no means of distinguishing costo-vertebral dislocations from fractures of the necks of the ribs, and no method of effecting reduction if dislocation be present. Hence nothing can be said on the subject of the treatment of this accident.

DISLOCATION OF THE RIBS FROM THEIR CARTILAGES. (*Costo-chondral dislocation*.)—This accident closely simulates fracture of the ribs, and indeed, during

life, it is not possible to determine whether the separation has or has not occurred exactly at the junction of the bone with the cartilage. Such a case must, therefore, be treated as if it were one of fractured rib—by replacement of the parts in the usual manner, with a bandage around the body [or strips of adhesive plaster], and a compress laid upon that part which shows itself most disposed to spring forward.

DISLOCATION OF THE CARTILAGES OF THE RIBS FROM THE STERNUM. (*Chondro-sternal dislocation*.)—The cartilage of the first rib has no synovial articulation, either with its rib or with the sternum. The next six costal cartilages are joined to the sternum by true articulations, with capsules and synovial membranes. These joints might theoretically be the seat of dislocations in two directions, that is, backward or forward. Clinical authorities are, however, for the most part silent about any but dislocations of the cartilages forward.

The most marked *symptom* in all these cases seems to be the hard projection formed by the head of the displaced cartilage, lying in front of its proper location.

The *treatment* consists in pressing the displaced cartilage back to its place, and there retaining it, as far as practicable, with bandages [or adhesive straps], and a compress. An assistant may aid the reduction by pressing his knee upon the spine, and drawing the shoulders backward. After replacement, the cartilage shows a decided tendency to spring forward, so that it may be difficult or even impossible to maintain the reduction. Something may be accomplished in assisting the retention by means of plaster of Paris, moulded upon the parts and held firmly in place by bandages around the body.

DISLOCATION OF THE BONES OF THE STERNUM.

Of this rare and dangerous accident Malgaigne has recorded ten cases, five of which ended fatally, owing to other complications. Traumatic cases are caused either by direct blows upon the bone itself, or by extremely violent backward flexing of the trunk, as when a person falls from a height, lighting upon a curb or fence. One case (Chevance's) was caused by violent, forward flexing of the body from a fall. Duverney, quoted by Malgaigne, reports a case in which the cause was lateral compression of the chest by a stone falling upon a man who lay upon his side.

SYMPTOMS.—In all but one of the recorded cases of dislocation between the upper and the second pieces of the sternum, the second piece has been thrown forward in front of the lower border of the manubrium. In this instance, originally reported by Sabatier, and afterwards included in the memoir of Maisonneuve, the lower bone was found to have been forced behind the upper by the direct violence of a fall upon a stone. In a majority of instances, the accident is only an accompaniment of more serious injuries, involving the viscera of the thorax or the spinal column. Mediastinal abscesses are prone to occur, even when the viscera are uninjured, and, when they point externally, must be evacuated by incision or aspiration, under very strict antiseptic conditions.

TREATMENT will often be uncalled for, inasmuch as the patient is so often at the point of death from his other injuries.

In those cases in which recovery has taken place, reduction has been easily effected by placing the patient in a recumbent position, or by flexing his body

across cushions laid under the back in such a way as to make extension upon the displaced bones. In all cases the patient should be confined to the horizontal position until some union has been secured.

DISLOCATIONS OF ENSIFORM CARTILAGE.—The *ensiform cartilage* has been dislocated in a number of instances, generally without fatal results. A blow upon the epigastrium is the only cause known to have produced this luxation. When it has occurred, the most prominent symptoms have been those due to the unusual pressure in this region caused by the displaced cartilage. Violent vomiting, with or without dyspnœa, is present, and the symptoms persist until reduction has been effected. Examination shows the cartilage to have been forced inward, leaving something of a depression at its natural location.

Reduction is indicated in all these cases to relieve the internal organs from the unnatural pressure, and after this has been effected, the symptoms may be expected to subside.

Sometimes the reduction may be accomplished by the fingers of the surgeon, elevating the cartilage to its place. In case the manipulation fail, an incision may be required, and instruments may be employed to aid in the replacement. In one case referred to by Poland,¹ after twenty-five days, during which time there were constant dyspnœa and vomiting, the cartilage was elevated by means of an instrument passed beneath it through an opening made for the purpose into the peritoneal cavity. Immediate relief was obtained, and the patient made a good recovery.

DISLOCATIONS OF THE CLAVICLE.

Owing to the form of its articulations, the clavicle is, of all bones in the body, the most difficult to retain in position. Luxations occur both at the sternal and acromial extremities.

I. DISLOCATION OF THE STERNAL END OF THE CLAVICLE.

The sternal end of the clavicle may be dislocated *upward, forward, or backward*.

FORWARD DISLOCATIONS are usually produced by blows upon the outer side of the shoulder, by which the clavicle is violently driven inward, so as to be forced at its inner end forward upon the sternum. In some instances the accident has resulted from severe muscular effort without external violence.

Symptoms.—The head of the bone lies beneath the skin, projecting in front of the sternum near its upper border, where it always may be felt, and, from the tumor which it forms, usually may be seen. In fat persons, however, or where much swelling has occurred, this symptom may be obscured.

The shoulder is thrown somewhat backward by the lever-like action of the bone, which forces its outer end in a direction opposite to that in which its inner end has been displaced.

Often the head is inclined toward the affected side by the patient's efforts to relax the painful tension of the sterno-mastoid. The prominence formed by the clavicular origin of this muscle stands out more under the skin than

¹ Holmes's System of Surgery, 2d edit. vol. ii. p. 572.

its fellow of the opposite side, being carried forward upon the sternum with the displaced head of the clavicle.

Careful measurement will show that the shoulder upon the affected side has fallen in somewhat towards the mesial plane of the body.

Treatment.—Reduction is effected without serious difficulty. An assistant should place his knee upon the spine in the upper part of the back, drawing the shoulders firmly backwards with his hands, while the surgeon, standing in front of the patient, forces the projecting end of the bone back to its place by means of direct pressure. The same result may be accomplished by having two assistants extend the arms powerfully by drawing in opposite directions, while the surgeon presses back the dislocated extremity as before.

In the treatment of this dislocation, the chief difficulty arises not in effecting, but in maintaining, the reduction. The bone lies so insecurely upon the narrow facet which it occupies on the sternum, that when once its ligamentous attachments are broken away, it has an inevitable tendency to slip out of its position.

The accompanying wood-cut (Fig. 557) shows the apparatus devised by Sir Astley Cooper for the after-treatment of these cases. Other surgeons,

such as Dr. Folts, prefer to employ an axillary pad to act as a fulcrum, using the arm as a lever to keep the shoulder pried away from the body, and binding the elbow firmly against the side. A compress is placed over the sternal extremity of the clavicle, and a figure-of-8 bandage applied across the shoulders.

There is no authority for an invariable rule of procedure in these cases, and that method must be chosen which seems best adapted by trial to the case in hand.

The attempt to maintain reduction often fails in the hands of the most eminent surgeons. Even the celebrated Desault, who claimed complete success with his apparatus for retaining

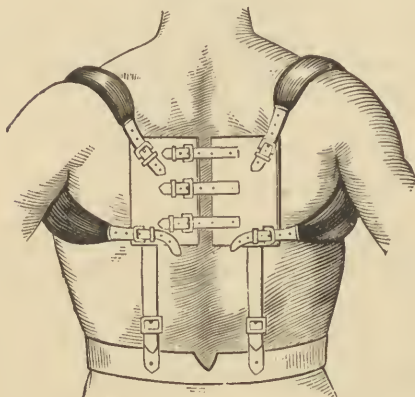
this bone in place, after reduction, is known in reality to have had a number of failures, and the same apparatus has proved very inefficient in the hands of all others who have employed it. Hamilton, in eleven cases under his observation, did not witness one instance of reduction being successfully maintained.

Dr. Gross suggests the fastening of the bone in place by silver wire; but as this operation must of necessity create disease of the sterno-clavicular articulation, with the possibility of suppuration and caries in spite of the most absolute antiseptic protection, it cannot be considered appropriate.

When the surgeon's appliances do succeed in maintaining the reduction, they should be worn continuously by the patient for five or six weeks, in order that firm union of the broken ligaments may be secured. But when, as usually happens, these efforts fail, the patient may have his liberty much earlier. Experience proves that when the head of the bone does not remain reduced, it nevertheless acquires a firm attachment in its new position, so that the shoulder is, ultimately, nearly if not quite as strong and useful as before.

In a young girl, in whom the altered position of the shoulder and the

Fig. 557.



Sir Astley Cooper's apparatus for dislocated clavicle.

irregularity at the top of the sternum might constitute a serious impairment of beauty, more time will be sacrificed by both patient and surgeon for the chance of a perfect recovery than in the opposite sex, where only the practical usefulness of the member is to be considered.

UPWARD DISLOCATION OF STERNAL END OF CLAVICLE.—This accident is extremely rare, the total number of recorded cases being only twelve, to which I can add two others from my own practice.

The *causes* of the upward dislocation are the same as those of the forward luxation, viz.: blows or falls striking upon the outer part of the shoulder, and driving the clavicle inward in such a way that, partly by the direct force and partly by the leverage, the capsular ligament is torn, and the head of the bone is driven from its seat on the sternum. The inter-clavicular and costo-clavicular ligaments must also be ruptured in severe cases.

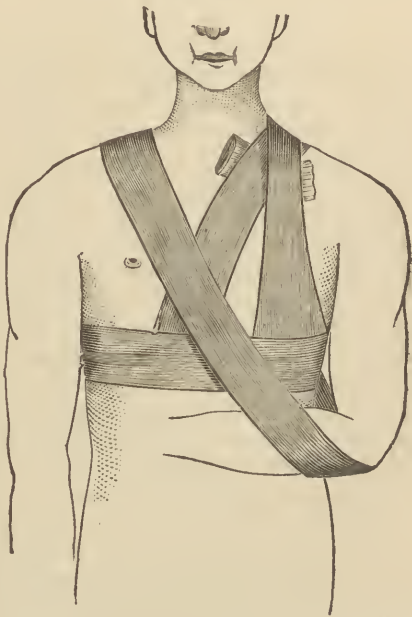
The *symptoms* resemble in the main those of forward dislocation, except in the position of the head of the bone, which lies above rather than in front of its natural seat. In Dr. Rochester's case, reported by Hamilton, the head of the bone lay in front of the thyroid cartilage, its presence in this extreme location giving rise to severe pain and dyspnoea, with loss of speech. The bone encroaches visibly upon the opposite side of the neck, with of course a corresponding falling in of the shoulder of the affected side.

Malgaigne's four cases, and that of Rochester, above mentioned, do not encourage us to expect perfect retention after the luxation has been reduced. The two cases which I herewith contribute, show one perfect recovery without deformity, as the result of a specially zealous and persevering trial, and one indifferent result, which represents the average success to be expected. A permanent displacement of half an inch or more will usually persist; but the functions of the shoulder and arm are practically unimpaired. The prognosis therefore is not grave.

In the case of a young lady of Chicago, who suffered this injury, I succeeded, by special efforts, in effecting a perfect restoration of the joint. The luxation was produced by a fall from a carriage, and was not seen by me for several days. Upon first examination, it was found that the sternal end was displaced about one inch above its normal seat. There was no great pain or swelling, but the bone showed a constant tendency to relaxation, when pressed down to its place.

The dressing consisted of a firm compress of folded cloth upon the head of the bone and its whole inner third, held in place by broad straps of adhesive plaster, about two yards in length, carried upon the front and back of the trunk, down as far as the waist, and crossing each other upon the compress in two or three different directions. Other plaster bands were carried obliquely downward under the affected elbow from the opposite shoulder, lifting the arm upward, and prying the shoulder outward over a thick axillary pad. The head was kept bent forward by bandages, and rotated toward the

Fig. 558.



Mode of applying adhesive straps for dislocation of sternal end of clavicle.

affected side so as to relax the tension of the sterno-mastoid muscle. The hand was kept supported in a sling. The dressings were occasionally reapplied for four weeks, after which they were removed, and the reduction remained perfect.

Such results are not generally obtainable, on account of the more severe nature of the injury, and the fact that the skin over the bone is often very intolerant of continued pressure.

Treatment.—Reduction would seem to have been simple in all the recorded cases, the treatment resolving itself into efforts to maintain the bone in its unstable socket, or rather facet, on the prominent top of the sternum.

Manipulation in a direction opposite to that of the force which brought about the dislocation, will promptly restore the bone to its place, from which it will promptly slip again when the force has been relaxed.

By some means the shoulder must be elevated, carried back, and drawn outwards, while a compress is made to hold the extremity of the bone in place. The arm must be supported by a sling and the elbow raised as in the dressing of a fractured clavicle. An axillary pad, rather large but soft, will afford the means of holding the shoulder out in its place. The compress upon the upper and inner portion of the clavicle must be held by bandages or adhesive bands, and the most perfect relaxation possible must be obtained in all opposing muscles, and especially in the sterno-mastoid and trapezius. Dr. Folts's apparatus, already mentioned, may furnish ready means of applying these principles. In each case the exact positions, bandages, and compresses, which seem on trial to be most likely to succeed, must be adopted and carefully preserved, as added facilities may, in this way, be hit upon, which no general directions can suggest.

DISLOCATION OF STERNAL END OF CLAVICLE BACKWARD.—*Causes.*—This dislocation is often produced by direct violence from in front, such as a blow upon the head of the bone, driving it back from its natural location. Like the upward and forward luxations, it also results from severe blows upon the outer extremity of the bone, and from compression of the opposite shoulders toward each other.

Symptoms.—Inspection, or the pressure of the finger, will always show the disappearance of the head of the bone from its socket, and by tracing its shaft inward, it is found to pass behind the sternum, carrying with it the clavicular origin of the sterno-mastoid, and thus rotating the head toward the opposite side. In some cases where the bone has been found above as well as behind its natural place, the tension of this muscle is supposed to have given it this direction. More commonly the displacement is somewhat downward as well as backward. The bone is moved somewhat toward the opposite side, carrying with it the shoulder. In its strange position among the important organs at the root of the neck, the bone may give rise to various alarming symptoms.

Dyspnœa and embarrassed deglutition have been present in most of the recorded cases. Once only is emphysema spoken of. Numbness and stoppage of circulation in the arm have been observed several times, from compression of the subclavian artery and of the brachial plexus. There would seem to be great danger of injury to the innominate artery should the right clavicle be affected, and very important nerve-trunks would also seem liable to laceration. In the few recorded cases, however, this has not occurred.

Treatment.—In most instances reduction has not been found very difficult, and, when accomplished, it has been more perfectly maintained than in the other forms of dislocation. Yet there is usually some slight deformity remaining. To effect reduction, the shoulder should be carried outward and

backward, or the outward movement alone may return the bone to place. The manipulations resemble those adopted for the other dislocations of the inner end of this bone, except that direct pressure, when used at all, must be applied to the sternum and not to the clavicle.

It has been found impossible in certain cases to accomplish reduction. Should this happen, and should there exist no obstruction to the respiration, to deglutition, or to the circulation of the arm, the surgeon may deem it best to leave the parts as he finds them, and may expect a nearly perfect restoration of the functions of the arm and shoulder. But when life is threatened by any dangerous symptom, or when, in the case of a young girl, it is deemed very important to prevent unsightly deformity, resolute measures must be resorted to. The overlying tissues may be divided, and the bone seized with lion-jawed forceps near its sternal end, so firmly that it can be drawn into place at the same time that assistants are drawing the shoulder outward and backward. Antiseptically performed, this operation would be almost without risk, and it might, like the subcutaneous section of ligaments in other regions, offer the only chance of success. The employment of a wire suture to unite the two bones, unless the dislocation be compound, is not to be recommended.

When, to relieve respiration or other vital function, the removal of the head of the bone from its position is a necessity, and other means have failed, the authorities recommend nothing less severe than excision of the sternal end of the clavicle, with due precautions against injury to the vessels beneath it. I am strongly of the opinion, however, that there could be no case of this sort which might not be relieved by dividing the clavicle with a chain-saw or bone-forceps near the junction of its inner and middle thirds, reducing the inner fragment by the help of the lion-jawed forceps, and treating the case afterward as a compound fracture, with the usual antiseptic precautions. If none of the vital functions were interfered with, neither excision nor division of the bone would be justifiable.

The after-treatment, when none of these severe measures have been resorted to, consists mainly in keeping the patient recumbent upon his back, the shoulders bent backward across an elevated cushion which is placed between them. Of course, care must be taken that no bands or compresses are allowed to rest upon the front of the clavicle, as these would tend to force the bone again from its articulating facet. Where cutting operations have been practised, the after-treatment is in principle the same, care being taken that the additional dressings used are not such as to cause backward pressure on the bone. After leaving his bed, the patient, for a week or two, should wear some dressing which will keep the shoulders drawn outward and immovable, and give rest to the muscles of the arm and chest. The axillary pad, with the elbow slightly elevated and drawn against the body by bandages or strong adhesive bands, will accomplish this end. From four to six weeks are required for the adhesions to become strong after rupture of these ligaments.

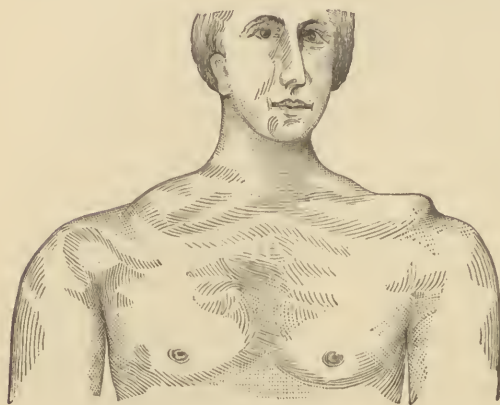
II. DISLOCATION OF THE ACROMIAL END OF THE CLAVICLE.

Surgical authors place all the varieties of this dislocation under two forms, the upward and the downward dislocations of the outer end.

UPWARD DISLOCATION OF ACROMIAL END OF CLAVICLE.—*Causes.*—In almost every recorded instance of this accident, the luxation has been caused by the scapula having been wedged or jammed inwards, so as to drive it beneath the overriding, outer end, thus tearing apart the ligaments of the clavicle which bind that bone to the acromion process. It is caused, therefore, by

nearly the same injuries as those which produce luxations of the sternal end, that is, falls or blows upon the extremity of the shoulder. When the shoulder is powerfully driven inward, the force acting in the direction of the axis of the clavicle may produce dislocation of either the sternal or acromial end. The causes which determine one or the other accident we do not know. An upward blow striking the lower border of the bone has caused this dislocation, and, on the other hand, downward blows which spend their force upon the

Fig. 559.



Upward dislocation of acromial end of clavicle.

scapula without touching the clavicle, may tear asunder the acromio-clavicular bands.

Pathology and Symptoms.—The rupture of the acromio-clavicular union by no means releases the collar-bone from its attachment to the shoulder-blade. The broad and strong coraco-clavicular band which anatomists describe as the *conoid* and *trapezoid* ligaments, is not injured in this dislocation, so that no great amount of separation can take place between the bones. When, therefore, the acromio-clavicular capsule is destroyed, and the escaped outer head of the clavicle springs upward from its shallow socket, it cannot, like the sternal end, slip freely to any

distance, but is checked abruptly by the coracoid ligaments, and departs less than an inch from its place. Impairment of motion and loss of power do not appear as prominent symptoms. Pain may be wanting.

The shoulder droops and falls inward, so that the bone projects not only upward, but in all cases outward, forming a prominence above the head of the humerus, a little resembling the flattening of the shoulder in dislocation of that bone. The careful surgeon, however, can never mistake the true condition upon close examination. There is no real flattening nor vacuity beneath the prominence, in dislocation of the clavicle. On the contrary, the round head of the humerus can be seen and felt in its natural place fully up under the acromion, and a straight edge laid along the arm will not touch the prominence by an inch or more.

Beside this, the relations of the scapular processes and clavicle are easily ascertained by examining with the hand. In most cases the projecting head of the clavicle will be found to slip readily in and out of its place with a sensible "click," so that there will be little chance of mistaking the nature of the lesion.

Treatment.—Reduction usually can be effected by pressing upon the extremity of the bone. It could be maintained in the same way, were it not that continuous pressure upon a bone which is so superficial sometimes ulcerates the skin, and puts an end to that form of treatment. Surgical reports show a certain percentage of failures from this cause. But it is to be borne in mind that we have the whole outer third of the clavicle to be utilized, and that with broad compresses the risk of injuring the skin is less.

When gentle pressure upon the displaced head will not cause it to return, assistance may be rendered by having an assistant draw the shoulder outward as well as slightly upward and backward. The operation is simple and easy.

The maintenance of reduction is rarely perfect, on account of the unwilling-

ness of most patients to submit to prolonged treatment. The horizontal position would help greatly in the management of these cases, and with this aid no doubt most cures would be perfect; but as the injury is scarcely a disabling one, even to the arm, patients seldom consent to confinement, and can with difficulty be induced to wear the necessary dressings for the proper length of time. The greatest obstacle to perfect retention is the tension of the trapezius, which tends constantly to lift the bone out of its socket while the weight of the arm carries the shoulder downward.

The arm must be lifted, and the shoulder held outward by an axillary pad, as in luxations of the sternal end. Inclining the head and neck toward the affected side tends to relax the trapezius muscle, and is therefore useful in assisting retention, where patients will tolerate the awkwardness of the position. All these measures are, however, but subsidiary to the main, efficient means of retention, direct pressure upon the misplaced extremity of the clavicle, while the scapula is forced upward by bands beneath the elbow. A firm compress should be laid upon the flat extremity of the clavicle. In my own practice, broad and long adhesive straps, whose centres pass beneath the elbow of the injured side, are drawn tightly and crossed upon the compress, where the ends of the straps pass each other, being then continued down about ten inches upon the chest and back.

At first, an added band from the elbow across the sound shoulder will assist in lifting the scapula. When this dressing has been well applied, the affected shoulder is seen to be held several inches above the other, and, to the touch, the border of the trapezius seems much less tense. After the first week, the bone will usually be seen to hold its position more firmly, but will still slip out if the shoulder be allowed to droop.

Less rigid dressings may now be used, still embodying, however, the compress and straps to confine and raise the arm. The forearm is to be kept in a sling, and the elbow drawn toward the opposite side, as well as upward. In all cases which have come under my personal observation, the retention has been much aided by keeping the hand of the affected side well up toward the sound shoulder, as nearly as possible in the position used in applying the test for dislocation of the humerus.

It will not be possible, in many cases, to induce the patient to endure the constraint of keeping the hand actually capped over the point of the opposite shoulder, but it is quite readily brought and retained far enough up for the finger tips to rest upon the head of the humerus.

The following case, reported by Dr. E. Wyllys Andrews, resulted in perfect retention without deformity. Thomas W., a young man employed in a wholesale millinery establishment in Chicago, tripped over a wire while at work, and fell heavily upon the left shoulder, the direction of the blow being toward the median plane and the arm being close to the body. He was removed from the roof of the building where the accident occurred, and was seen by Dr. Andrews a few moments afterwards. A large contusion over the deltoid muscle showed where the greatest force of the fall had been expended, and the patient described his fall as having been so unexpected that the arm had not been put out as usual, so that he had been thrown violently, at full length. There were slight contusions on the outer side of the arm as far as the elbow. The patient complained of a sense of helplessness and dropping down of the shoulder, but not much of pain. He was found sitting upright in a chair, his head instinctively bent toward the left, hurt shoulder, which he kept lifted three-fourths of an inch above the other by pushing upward upon the elbow with the other hand. The elbow was also drawn somewhat across, in front, and hugged tightly against the body.

As first seen, the position was not very unlike that which afterwards proved to be the best suited to retaining the dislocated bone in place. The acromial end of the clavicle projected under the integument, about half or three-quarters of an inch above, and slightly outward and backward from, its articular facet on the acromion. Slight pres-

sure with the thumbs upon the projecting bone caused it to slip with a palpable, though not an audible "click," into its socket, where it seemed disposed to remain while the patient kept his head bent and his shoulder elevated, but whence it was seen to slip upon slight change of position. With a four-tailed bandage, applied as for a fractured clavicle, the elbow was pushed upward and the forearm drawn across the body, so that the fingers reached the tip of the opposite shoulder. That portion of the bandage which encircled the body, was tightly drawn, and was made wide enough to bind the lower part of the scapula tightly to the thorax. A broad band was carried directly over the injured shoulder from front to back, and beneath this was placed a soft but thick pad of folded, surgeon's lint, with a layer of cotton batting next to the skin, covering three and a half inches of the outer end of the bone. From first to last no pain or ulceration was caused by this pad. The tip of the elbow did become sore, and, after the first week, had to be relieved from pressure and kept covered with antiseptic cerate and gutta-percha tissue. Some other abrasions upon the outer surface of the arm were daily dressed and protected in the same way, and powerful pressure of the bandages over the dressing seemed in no way to retard their healing. The bandages were worn for four weeks, after which a broad band of adhesive plaster, with fan-shaped extremities, was passed across a small compress over the luxated bone, and was worn for two weeks longer. Union of the ligaments then seemed complete, and the dressings were removed. After three months no relapse had occurred, and there was no visible deformity.

In all cases there must be firm compression upon the flat extremity of the clavicle, and some means of raising the scapula by supporting the elbow. An excellent appliance for this and some other injuries about the shoulder is Folts's dressing, which consists of a strong band passing over the top of the shoulder, and buckled at its ends to a sling which incloses the flexed elbow. Still another method which has been successful, is to use a long elastic band, applied in the form of a species of figure-of-8, whose crossing is upon the compress over the head of the bone, one loop being beneath the elbow on the affected side, and the other beneath the opposite axilla.

The horizontal position in bed undoubtedly favors most perfect retention, and is of itself sufficient in some cases to insure success. This may often be a valuable aid in cases of young women, where it is of great importance to secure recovery without visible deformity. It is to be remembered that the skin covering the acromial end of the bone is rather intolerant of pressure, as it is also at the point of the elbow. Ulceration from pressure occurring at these points often defeats the surgeon's best efforts. When this occurs, the ultimate result is not serious as to the usefulness of the arm, but a slight prominence remains over the acromion process.

DISLOCATION DOWNWARD.—Downward dislocations of the acromial end of the clavicle are very rare, only five cases having been published. The injury seems to have been caused by violence exerted downward upon the clavicle. The most prominent symptom is the changed location of the head of the bone, easily felt under the skin. The treatment, as far as can be inferred from the recorded cases, should consist in drawing the shoulders outward and backward, by which reduction is effected. The bone has been found well disposed to retain its place when reduced. In order to insure retention, a broad bandage should be placed around the body beneath the axilla, to bind the scapula firmly to the thorax. When the lower extremity of the shoulder blade is thus compressed against the chest wall, the coracoid process will project well forward under the collar bone, and will effectually prevent its redisplacement.

DISLOCATION OF THE SCAPULAR END OF THE CLAVICLE BENEATH THE CORACOID PROCESS.—This rare accident appears six times only in surgical literature. A fall upon the shoulder has been the cause in each instance. The symptoms are very well marked, there being a deep depression at the outer end

of the bone, and a corresponding lifting into prominence of the coracoid and acromion processes. The clavicle slopes decidedly more downward than its normal fellow, and its acromial end is felt projecting into the axilla. The small number of recorded cases of this injury, deprives us of any very copious knowledge of the results of treatment. In most instances the dislocation has been reduced by having an assistant pull the shoulder backward and outward, while the surgeon has grasped the bone, and has sought by manipulation to disengage it from under the coracoid process. Pinjon tried this method in vain, and the patient had the dislocation reduced next day by an empiric. It has been suggested, with some show of reason, that, instead of pulling the arm outward and backward as above recommended, thus putting the pectoralis major upon the stretch and causing it to resist the desired movement, it would be better to keep the elbow against the side, and pull the humerus outward by the hands in the axilla. Hamilton is of the opinion that this curious sub-coracoid dislocation, the belief in which rests solely upon the evidence of two surgeons, is wholly a fictitious injury, and an attempt at deception practised for the sake of notoriety.

SIMULTANEOUS DISLOCATION OF BOTH ENDS OF THE CLAVICLE.—This rare form of luxation is said to have occurred in a few cases. Such an injury, in a person not otherwise fatally hurt, might be reduced in accordance with the rules already given for the separate luxations.

DISLOCATIONS OF THE SHOULDER.

Owing to the anatomy of the joint, which fits it for very free motion rather than for secure repose, the shoulder is dislocated with great frequency. The main features of the accident are well agreed upon, but there are certain varieties of position and peculiarities of injury, which are yet matters of dispute among authors. American surgeons, who are still greatly influenced by Sir Astley Cooper's teachings, generally admit complete luxation in three directions, viz.: downward, forward, and backward, and with the frequency in the order named.

Partial dislocations, so called, are usually examples of faulty diagnosis, though such injuries do occur. It is possible that the force causing the accident may cease when the head of the bone has only partly rent its way through the capsule, and that thus the part may be held in a tight ligamentous grasp, without having fully escaped from the glenoid cavity. These cases are, however, very rare. Frequently the long tendon of the biceps is ruptured, and, a part of the anterior retaining force being thus removed, the head of the bone is pushed somewhat forward, and gives a false impression of partial dislocation. The inflammation and thickening of the anterior portion of the capsular ligament, by increasing the prominence, adds to the delusive appearance. Fractures of the border of the glenoid cavity may also give rise to slight displacements simulating partial dislocation. It is said that, in spite of assertions to the contrary, a true partial dislocation forward occurs, in consequence of the bone slipping forward to the coracoid process, and the biceps tendon gliding back behind the head of the humerus, and by its tension holding it forward against the coracoid, although the anatomy of the parts is such that the head could never rest in this position except for the support of the displaced tendon behind.

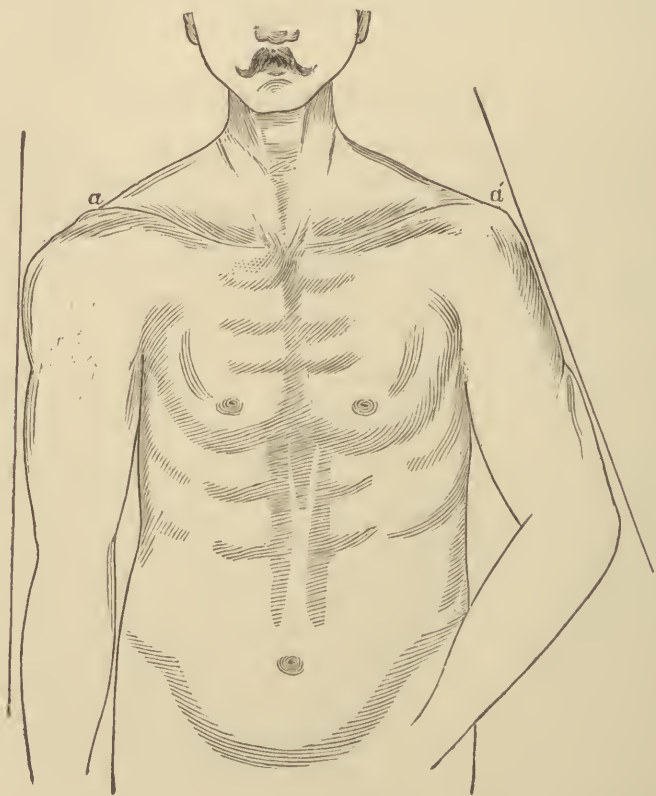
Old dislocations of the shoulder have generally been considered irreducible at the end of three months, but many instances of success have been recorded at later periods. Still, great care must be exercised in these cases, for fatal

injuries to the axillary artery and vein have occurred, especially when forced extension has been made in an upward direction. In some instances, a dislocation of the shoulder leaves a permanent deficiency in the capsule, of such a nature that relaxation occurs throughout the remainder of life from very slight causes.

SYMPTOMS.—There are several injuries which perplex the general practitioner by their resemblance to dislocation of the humerus, so that it is important to have a clear idea of the mechanism and symptoms of this lesion. The proofs of the luxation are these:—

(1) *Flattening of the Shoulder.*—In the natural position, the tuberosity of the humerus stands out laterally beyond the end of the acromion process, giving the deltoid region the beautiful curve so prized by sculptors and painters, and aptly called by the common people of some nations the “apple of the shoulder.” When the joint is dislocated, the absence of the bone causes the deltoid muscle to fall in, and to present, instead of the proper curve, only a blunt angle, where it leaves the acromion, and to slope downward and outward almost in a straight line from its origin to its insertion. If the patient

Fig. 560.



Subglenoid dislocation of humerus, showing flatness beneath acromion. *a, a'*, tips of acromion processes. The ruled lines indicate the test for dislocation by means of a straight edge laid on the arm.

is very fat, or the joint much swollen, this symptom is less conspicuous, but seldom altogether obliterated. If the finger of the surgeon pass downward

and outward from the acromion in examining a sound shoulder, it comes at once upon the tuberosity of the humerus, which may be grasped between the thumb and finger, and by rotation of the limb can be made distinctly obvious unless the swelling be very extraordinary. Slight differences exist among patients, or even between the two shoulders of the same patient in the distance of the tuberosity below the acromion; but in a true dislocation, the finger presses into a deep vacuity from which the head of the bone has completely gone.

(2) *Position of Caput Humeri*.—If now the head of the humerus be sought for, it will be found as a round, smooth, bony tumor, in the axillary, the coracoid, or the scapular region, according to the direction of its displacement.

(3) *Position of Elbow*.—If the patient be set upright, with both acromions on the same level, the arm of the affected side will be found to stand out obliquely from the body, so that, if the shoulders be kept level, the patient cannot voluntarily press his elbow against his side, and if the surgeon press it in, it springs out again as soon as the pressure is removed. If the dislocation is forward, the elbow is inclined outward and backward; but if the dislocation is backward, the elbow inclines more forward. These positions are due to the fact that, when the head of the humerus is thrown downward, the deltoid and the strong upper portion of the capsular ligament are put forcibly on the stretch, and throw the elbow outward, while if the direction of the dislocation be backward or forward, the untorn anterior or posterior parts of the ligament, and the corresponding parts of the deltoid, being stretched, act to give the elbow its characteristic position. If left to himself, the patient finds it painful to sustain the elbow in this position, and relieves himself by lowering the affected shoulder, and flexing his body in the same direction, so as to relieve the tension by allowing the elbow to hang more nearly vertically. In this position, the whole affected shoulder will be seen to be lower than the sound one.

(4) A favorite test of dislocation [known as *Dugas's test*], is to place the hand of the affected side on the prominence of the sound shoulder. If the shoulder is dislocated, the elbow will be elevated and will stand out prominently in front of the breast, and no moderate force will cause it to lie down against the sternum. This is a test of decided value, but, for it to be well applied, it is often necessary to disarm the patient's voluntary muscular resistance by the use of an anæsthetic.

(5) *Test by Application of Rule*.—Another striking symptom is elicited by taking a straight rule, and applying it along the outer border of the humerus, from the external condyle to the acromion. If the bone be in correct position, the rule will stand out some three-quarters of an inch from the acromion; but if the head of the humerus have moved inward, either from dislocation or from fracture of the neck or glenoid cavity of the scapula, the rule will rest against the point of the acromion, unless borne outward by unusual swelling or other deformity.

(6) *Character of Crepitus*.—The dislocated shoulder, when freely moved, sometimes yields a ripply, rubbing sensation, as of hard parts against tense ligamentous edges; but this is very different from the hard, gritty crepitus of newly fractured bone.

(7) Finally, if a dislocation be reduced, there is generally *no spontaneous tendency to a relaxation*, but in the fractures of this region there is often a strong tendency for the broken parts to slip out of place.

If, now, we bring together these symptoms in tabular form, and place after them the symptoms of the different fractures of this region, the means of diagnosis will be clear:—

SIGNS OF DISLOCATION.

- (1) Flattening and vacuity below the acromion.
- (2) Head of bone felt in axilla or elsewhere.
- (3) Elbow held directly or obliquely outward.
- (4) Hand being capped over sound shoulder, elbow cannot be easily made to touch breast.
- (5) Rule on outside of arm touches acromion.
- (6) No true bony crepitus.
- (7) When reduced, bone remains in position.

SIGNS OF FRACTURE OF NECK OF SCAPULA.

- (1) Flattening and vacuity below acromion.
- (2) Head of bone and glenoid fragment felt in axilla.
- (3) Arm hangs nearly vertically.
- (4) Rule on outside of arm touches acromion.
- (5) Hand being capped over sound shoulder, and patient under influence of anæsthetic, elbow can with moderate difficulty be pressed against breast.
- (6) True bony crepitus.
- (7) When reduced, parts again become spontaneously displaced.
- (8) Coracoid process can be moved separately from body of scapula.

SIGNS OF FRACTURE OF GLENOID CAVITY.

Symptoms similar to fracture of neck of scapula.

SIGNS OF FRACTURE OF LOWER RIM OF GLENOID CAVITY.

All the symptoms of a true dislocation, but the bone slips out and in with slight force.

SIGNS OF FRACTURE OF ANATOMICAL NECK OF HUMERUS (NOT IMPACTED).

- (1) Generally no displacement and little flattening under acromion.
- (2) Head of bone not felt in axilla nor in any other abnormal place.
- (3) Arm hangs nearly vertically.
- (4) Hand being capped over opposite shoulder, elbow can be pressed against breast.
- (5) Bony crepitus.
- (6) If intracapsular, necrosis follows.

SIGNS OF FRACTURE THROUGH TUBERCLES, WITH DISPLACEMENT OF LOWER FRAGMENT INWARD.

- (1) Some flattening below acromion, but finger finds head of bone there.
- (2) Displaced fragment, if felt in axilla, lacks smooth round contour of head of bone.
- (3) Arm hangs nearly vertically.
- (4) Hand being capped over sound shoulder, elbow can be pressed against breast.
- (5) Bony crepitus.

Some months after a fracture of the neck or tubercles of the humerus, we occasionally find surprisingly prominent exostoses in or near the axilla, causing the careless observer to fancy that the prominence felt is the dislocated head of the bone. In such a case, the presence of the tuberosity in its proper place beneath the acromion is sufficient to prevent a mistake. A similar growth from a fractured coracoid, neck of scapula, or glenoid cavity, raises similar anxieties, and the question of diagnosis must be settled by a rigid study of the mechanism of the injury, and of all the relations of the parts.

ANCIENT DISLOCATIONS OF THE SHOULDER.—It has been stated that dislocations of the humerus become hopeless after three months. In some cases, however, these dislocations are reducible at a much later period, and efforts at reduction ought always to be made when the cases are seen within five or

six months after the injury. Subcutaneous division of portions of the resisting ligaments will sometimes greatly assist these efforts. This is justified when accompanied by full antiseptic precautions. It is to be remembered that there is great danger of rupturing the axillary vessels by making too violent extension in an old luxation at the shoulder. More than one fatal termination has followed this accident, where force has been incautiously used about the axilla in violent efforts at replacement.

DOWNWARD DISLOCATION OF THE HUMERUS.—Downward or subglenoid luxation, said by some to be the most common of all dislocations, is found by Hamilton to be the second in order of frequency. It consists of a downward and inward displacement of the head of the humerus into the axilla.

Causes.—Aside from direct blows, which not rarely produce dislocations downward of the humerus, falls upon the hand or elbow are found to be the chief causes. Any sudden raising of the arm to or above a horizontal position, may cause the bone to break through its capsule at its thin, inner and lower surface, and to slip downward into the axilla. This has been known to occur by the slipping of a crutch. I found it to have been produced, in one instance, by the act of striking out in swimming. The patient, a rather corpulent but not muscular man, felt a sudden pain and helplessness at the moment of throwing his arms forward to make a stroke, and had to be lifted from the swimming-bath by the assistants.

Symptoms.—Pain is usually rather severe, and quite often numbness, and a prickling or tingling sensation, are felt in the hand and arm. Very commonly the axillary vessels are so compressed that the radial pulse is imperceptible. The usual roundness of the shoulder is lost, now that the head of the bone has left its socket, and the part has a flattened and angular appearance from the outward jutting of the acromion process, while below this there can be felt, if not seen, a depression or vacancy as compared with the opposite side.

More accurately to test the question as to whether the head has or has not left its socket, a rule may be laid along the outer aspect of the arm. This straight edge, in the normal condition of parts, stands off more than half an inch from the tip of the acromion. When, on the contrary, it rests upon this point with the arm hanging near the side, the sign may be taken as infallible that the head of the bone has left its true position, either by dislocation or by fracture of the scapular neck or glenoid cavity. (See Fig. 560.)

In corpulent persons, the vacancy below the acromion is palpable rather than visible; but I have never yet met with a case in which this sign alone would not have been sufficient to settle the diagnosis. A number of other symptoms are customarily observed: The elbow, instead of hanging close to the side, is carried more or less outward, on account of the throwing inward of the opposite end of the humerus. The head itself can be felt in the lower and anterior axillary border, more or less tightly held against the chest-wall by the tension of the pectoralis major and latissimus dorsi. It may be separated one or two inches from the coracoid process. The test of placing the hand of the dislocated arm upon the opposite shoulder is here applicable, as in all dislocations of the humerus. The elbow in this position cannot be made to come in contact with the body.

ANTERIOR DISLOCATIONS OF THE HUMERUS.—These occur in two positions, giving rise to the *subcoracoid* and the *subclavicular* varieties of forward dislocation.

In *subcoracoid* dislocation, the head of the humerus rests upon the anterior surface of the neck of the scapula and border of the glenoid cavity, below the

coracoid process, or even a little further forward, where it is plainly visible, or certainly can be felt, through any amount of swelling of the soft parts.

The *subclavicular* dislocation is a rare form in which the head of the bone is found underneath the clavicle, and internal to the coracoid process.

The usual symptoms of humeral dislocation are present, as already described, the main differential signs of the anterior form of luxation being the different positions of the head of the bone, as seen or felt through the soft parts. In this form the elbow is often carried slightly backward, as well as outward from the side.

POSTERIOR DISLOCATION OF THE HUMERUS.—Backward or subspinous luxations are not often met with. In this form the head of the bone is found to be behind and below its socket, having slipped back upon the scapula below the horizontal ridge, called its spine. In this abnormal position it is readily detected by the hand if not by the eye. The remaining symptoms are those common to all the dislocations of the shoulder. [The most striking symptom of this rare form of dislocation is the excessive prominence of the coracoid process, over which the skin is tightly stretched.]

TREATMENT OF DISLOCATIONS OF THE HUMERUS.—In most cases an anæsthetic will be required, to aid the reduction. The steps of the operation are nearly identical in all the forms. Necessary variations will be obvious in the application of direct force to the head of the bone, to push it toward its socket. For the most part, extension and counter-extension only are invoked, as the essential elements in reduction. So simple and harmless are the traction methods, that they are by far the most frequently employed; but the use of the shaft of the humerus to obtain leverage, and other manipulations somewhat resembling those used in luxations of the hip, are advocated by a few surgeons. As in other joints, the principal obstacle to reduction is probably the untorn portion of the capsular ligament, which, in the shoulder, is always at the upper side; but Dr. Hamilton, of Rochester, considers the tension of the pectoralis major and latissimus the chief resisting forces, and undoubtedly the muscles exert more opposition here than in other dislocations, on account of the normally exposed and loose condition of the shoulder-joint. There will thus be seen to be an antagonism between the powerful muscles which draw the bone against the chest, and the strong, upper part of the capsule which is rendered most tense in the downward position of the arm; so that a position which most relaxes the latter will encounter most muscular resistance, and *vice versa*. Different authorities, therefore, claim advantages for each position, and success can undoubtedly be obtained with either, since the scapula is so loosely connected that ultimately the joint will probably be dragged in the most favorable position, in whatever direction traction be applied. Many times a change of direction is advisable, during the act of making the extension. My own experience, and that of many other operators, leads me to believe that the position with the shaft of the humerus at right angles to the body, is that which gives the greatest facility. This puts certain strong muscles upon the stretch; but has the obvious advantage of relaxing not only the untorn ligament above, but the powerful deltoid muscle.

Description of Methods of Reduction.—The following plans require no mechanical aids:—

First Method.—Let the patient be laid upon his back upon the floor, with suitable pillows and blankets, and then anæsthetized. The surgeon, after removing both shoes, seats himself at the affected side of the patient. Extending the arm to a right angle with the body, the surgeon grasps it firmly with both hands, making counter extension with the ball or heel of one foot

in the axilla, and with the ball of the other against the acromion process, being careful that the foot above the shoulder does not encroach upon the space which will be required for the head of the bone when about to slip into its socket. He then proceeds to make steady and gentle extension.

The upper, untorn part of the capsule in this position offers no resistance; but, on the contrary, aids in reduction when the head of the humerus has been well drawn outward, by pulling the glenoid cavity downward toward it. This tilting of the scapula is an important element in the reduction, and may be greatly aided by the foot upon the acromion, also giving it a downward movement at the proper moment.

In a large majority, perhaps nine-tenths, of the cases met with, this simple manœuvre will bring about reduction at the first attempt, and with very slight force of traction—less, indeed, than is required in any other method with which I am acquainted. Increased power of traction for older or more difficult cases is best obtained by means of a elove-hitch applied above the elbow, and a “jack towel” passed across the surgeon’s shoulders.

Second Method.—Let the patient be placed in a sitting posture, without an anæsthetic, and a strong sheet be passed around the body just below the axilla, for counter-extension, and held by assistants upon the opposite side. This may be kept from slipping downward by means of a small strap over the shoulder. Other assistants make extension upon the dislocated limb at right angles to the body, the surgeon manipulating with his hands the scapula and humerus so as to make the articular surfaces approach each other. This method was a favorite with the older surgeons, but, since the introduction of anæsthetics, has been less in vogue, since the raising of an anesthetized patient to a sitting posture would be a dangerous and unwarrantable act.

Instead of the sheet for counter-extension, Dr. N. R. Smith, of Baltimore, was accustomed to make traction upon the opposite wrist. In principle, these methods of counter-extension are the same.

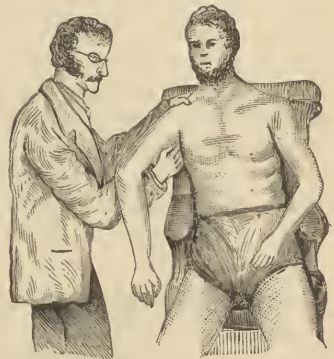
While assistants are making traction, the surgeon may help the reduction in obstinate cases by having a band passed beneath the humerus near its upper end, with which he helps to draw the bone outward and upward.

In cases of difficulty it is allowable, after the failure of milder efforts, to make manipulations for the purpose of breaking further the fibres of the ligaments, and enlarging the narrow “button-hole” opening in the capsule. This is done by combining with the traction forcible rotation in a right and left direction, using force enough to only slightly lacerate the ligamentous bands, and to give a freer space for returning the bone to its articulation.

Third Method.—Another method has long been known among surgeons as “Cooper’s method.” It consists of downward extension, with the heel in the axilla, somewhat as in the plan first described, except that the surgeon places himself in a position parallel to the axis of the patient’s body, and pulls downward, using at the same time the leverage of the shaft of the bone, to pry the head outward over the foot as a sort of fulcrum.

This method is the least economical of force, but, on account of the movable condition of the scapula, which allows it to be dragged around by the tension exerted at the upper edge of the glenoid cavity, very good results

Fig. 561.



Direct reposition of dislocated humerus.

are thus procurable. Although not equal to extension at right angles, it has always been a favorite method, and has succeeded in thousands of cases. While having the obvious advantage of relaxing the pectoralis and latissimus muscles, it puts on stretch the powerful deltoid and the upper untorn half of the capsule. Most obvious and important of the objections to downward extension, however, is the fact that the head of the bone is already below its socket; and it seems irrational to use force in a direction opposite to that in which it is desired to make the head of the bone advance. Were it not for the great mobility of the scapula, I am convinced that Cooper's method would never effect reduction at all. As it is, more force and time are needed for it than for any of the other plans described.

But recent shoulder dislocations are extremely easy of replacement, and Cooper's plan, though theoretically faulty, has probably been used in more cases than all other methods combined.

The operation is best conducted with the patient upon a lounge or couch; but the mattress may be laid upon the floor, or an ordinary table may be used in an emergency. Some surgeons prefer to use an axillary pad, as a roll of cloth or ball of yarn, upon which to rest the heel in making counter-extension.

By little and little the parts yield under steady traction; the glenoid cavity presents more downward, being drawn around as we have described, and the bone is felt or heard to slip into its socket. Either the clove-hitch and a strong linen band or rope, or the hands alone, may be used in making extension. Rotation to loosen fibrous obstructions is to be effected by using the forearm, flexed to a right angle, as a lever. I am strongly opposed to the use of Skey's iron knob in these cases, believing that the heel or a softer pad is equally efficient.

Fourth Method. (Upward Extension.)—In order most perfectly to relax that portion of the capsule which is still untorn, and also the deltoid muscle, some

Fig. 562.



Reduction of dislocated humerus, with knee in axilla (Cooper's method).

surgeons have advocated and practised reduction by extension obliquely upward and outward. This position puts to the extremest stretch the pectoral and dorsal muscles, and is probably, therefore, not quite as favorable as an intermediate position. Good results, however, are obtained by it, and it serves as one of the resources invoked in difficult cases. The danger of rupturing the axillary artery or vein is greatest when this position is chosen, on account of the distance through which the head is made to pass in sweeping the arm upward. It should be very cautiously employed in ancient dislocations, in which this accident is particularly liable to occur.

Fifth Method.—Various methods have been devised for combining traction and leverage by placing a fulcrum in the axilla. Of these, Sir Astley Cooper's method of using the surgeon's knee, is to be mentioned as one frequently described, and probably quite safe and effective, but very little used by American surgeons. In this method, the patient is seated in a chair, the surgeon standing by his

side with one foot upon the edge of the chair, and his knee in the patient's axilla, making counter-extension, while extension is made with the hands, the

knee serving also as a fulcrum on which to pry the shaft of the humerus, while the arm is at a right angle with the body, the forearm also being flexed to allow rotation to be made. For great force, *Jarvis's adjuster* is far more efficient and safe than the pulleys, as it enables the surgeon to use manipulation in connection with extension. Its use is to be reserved for ancient dislocations.

Sixth Method. (Manipulation.)—By manipulation is meant a combination of the various passive movements, such as flexion and extension, adduction and abduction, circumduction and rotation, by which dislocations of the shoulder can be reduced without the employment of great traction. Manipulation methods in the case of this joint do not afford such striking advantages as in some other parts of the body, notably the hip, but efforts have been made to classify and perfect these methods in reference to the various forms of the injury, and they deserve description. At present they are much in need of further trial, the evidence of their efficacy being solely based upon the small number of cases reported by the advocates of these methods, Prof. Henry H. Smith, of Philadelphia, and Prof. J. W. Hamilton, of Columbus. Prof. Hamilton¹ believes that the ligaments are less important than the muscles in opposing reduction, basing his theories of manipulation upon the idea of relaxing muscular resistance; but it is now known that dislocated joints are resisted in their return far more by the untorn parts of their capsules than by any other opposing element. In order to secure the least possible muscular resistance, this surgeon directs that the arm be slightly abducted and rotated inward, with the elbow bent at a right angle.

Obviously, this position puts to some tension the pectoralis, latissimus, triceps, and teres major, but it is claimed that the last named has little influence, while the other three are relaxed to some extent by the inward rotation. The pectoralis and latissimus not being attached to the scapula, but to points much further away from the joint, are more easily overcome than the shorter scapulo-humeral muscles. The following is Prof. Hamilton's plan of manipulation:—

Carry the injured arm from the side, keeping it horizontal, till, with the axis of the body projected upward, it makes an angle of forty-five degrees. At this stage, flex the forearm to a right angle with the arm. In a state of medium rotation the forearm will, at this stage, be in a direction perpendicular to the table. Keeping the forearm in this state of flexion, and for the present the arm in this state of rotation, let the member be grasped by an assistant, say, grasping the lower end of the humerus with the right and the wrist with the left hand. If the pectoralis and latissimus muscles are found tense, wait until they become relaxed. Now let the surgeon take his position at the head of the table, between the patient's arm and head. He will be able to place the tips of two thumbs on the tip of the acromion, and the tips of all the fingers on the displaced head of the humerus. Everything being thus made ready, direct the assistant to pull steadily but slightly with the right hand; at the same time, the surgeon presses in opposite directions upon the tip of the acromion and the head of the humerus, or, in other words, presses them gently towards each other. With the most insignificant expenditure of force, the bone will probably fall almost instantly into position. If it does not, rotate the arm, so that the forearm will be carried from a perpendicular, inward, to an angle of forty-five degrees, and repeat the movement; the rotation inward may be even more increased, or, this failing, outward rotation may be tried.

Fourteen successful cases are reported as treated by this surgeon in the manner above described.

¹ Ohio Medical Recorder, April, 1877.

AFTER-TREATMENT.—After reduction of a dislocated shoulder, the great proneness to relaxation requires that the arm shall be supported by binding the elbow against the body, and that a small axillary pad shall be used to keep the head of the bone well out. This may be worn six or eight days, after which more freedom of the arm can safely be allowed. The patient is to be cautioned that for several weeks he must on no account raise the arm above the shoulder-level, or put it to any violent use; but other movements should be practised, at least passively, and the axillary pad should be removed.

DISLOCATION OF THE LONG HEAD OF THE BICEPS from the bicipital groove sometimes causes a puzzling deformity after a successful reduction, or even when there has been no luxation. Without being ruptured, this tendon is not certainly known ever to have been dislocated, although commonly so stated by old authors. No treatment is beneficial except rest to the limb.

OLD DISLOCATIONS OF THE HUMERUS.—A majority of dislocated shoulders become incurable after twelve weeks, though a small number are reducible after a much greater length of time. The shoulder has been reduced after two years, to my personal knowledge, and doubtless many ancient cases have been too hastily abandoned as intractable, for fear of injury, their hopelessness being prejudged rather than satisfactorily tested, from the slight encouragement given in most surgical works.

Jarvis's adjuster is so essential an instrument in old dislocations, that little success or safety can be expected without it, save in cases not really very difficult. I do not know what success could be expected in ancient dislocations, where a combination of strong traction and very free manipulation offers the chief hope of loosening inveterate adhesions, were it not for the facility afforded by this inimitable piece of mechanism for obtaining these two forces in conjunction. Yet it is certain that the data upon which conclusions have been based heretofore have been mainly in the use of the old methods.

The danger attending efforts to reduce old dislocations of the humerus must be accepted as a constant factor, which should be well understood by the patient before submitting to this operation, exactly as in other surgical procedures. Besides the fracture of the surgical neck, and even of a rib, which have been known to occur in the violent efforts of operators to effect reduction, there is constantly to be feared a rupture of the axillary vein or artery, or both, accidents which usually have proved fatal. In one case this resulted from the sharp angle of a boot-heel carelessly used for counter-extension. Drawing the limb forcibly upward, subjects the vessels to a violent strain in all cases where they have become glued to the head of the bone by inflammatory adhesions in its new position. In the same manner, the innervation of the parts below the axilla may be wholly or partly destroyed. It is not known that any care can enable us to know what cases are most subject to this risk. The accident has usually occurred in the practice of eminent surgeons, and so frequently that the danger is certainly no slight one. In one remarkable case, recorded by Guérin, the surgeon tore an arm completely from the body of an aged woman, in making violent extension to reduce a long displaced humerus.

Notwithstanding the extreme caution necessary, and the actual danger to life, even with extreme caution, I believe that within six months after dislocation, a certain amount of effort is justifiable, when the patient so desires after a full knowledge of the circumstances, especially in those frequent instances where, from pressure upon the axillary trunks, the arm is rendered useless, or there are great distress and pain. Even after a long period, adhesions do not always take place to a serious extent, and reduction, when

secured, affords a nearly perfect restoration of the functions, no matter how long the time which has elapsed. Those cases in which extensive organic changes have occurred about the socket, are probably cases in which the new adhesions also are most developed, and in which reduction is therefore not easy.

The following remarkable case, which has not as yet been reported, is unparalleled in the records of surgery:—

Mr. B., a patient of my friend Dr. Rice, a prominent physician at La Moille, Illinois, met with an accident in November, 1877, by which he dislocated his shoulder. The patient, who was a farmer, failed for some reason to obtain proper treatment, and applied after eighteen months to Dr. Rice, who discovered the true nature of the injury, and made patient efforts to reduce the luxation. After using as much force as he dared, this physician pronounced the case beyond cure, and advised that no more hope be entertained of replacing the bone, as no nerves seemed pressed upon, and as the arm was still measureably useful to the patient.

In November, 1881, four years after the injury, the man was riding upon a horse, and at the same time leading a blind horse behind him, by a halter, which he had carelessly wound about the hand of the arm dislocated four years before. While in this position, the animal behind, becoming startled, suddenly jumped back, and Mr. B., who was unable to release his hand from the halter-strap, was dragged forcibly backward, so that the traction was both backward and, as he leaned further back, somewhat upward. The shock of this sudden strain was so severe that the patient was taken to his house and placed in bed, it being believed by himself and others that he was seriously hurt. He slept for some hours, the pain not being severe, and, upon awakening, himself discovered that his arm was changed in some way. Further examination showed that the luxation had been reduced, and the member soon recovered its mobility, and nearly its old strength.

From this extraordinary and exceptional case it is not to be concluded that there is ordinarily much hope in cases as old as the above. Much less violence has not unfrequently produced fatal results, yet a percentage of cases are doubtless reducible up to six months' standing by the use of the adjuster, and possibly by the subcutaneous sections already spoken of. I deem the upward extension to be dangerous in attempting to reduce ancient dislocations, but believe that traction at right angles to the trunk is reasonably safe, if not pushed to extreme violence.

When thoroughly relaxed by ether, the patient, being laid upon his back, may have Jarvis's adjuster applied, and carefully fitted; or, in default of this, a piece of apparatus specially constructed, with a rack and pinion, so as to allow of mobility. Least valuable and most dangerous of all appliances is the compound pulley, although this even will permit of rotation. Let the extending band be attached just above the elbow, the forearm being flexed at right angles, and let traction gradually be made at the same time that the arm is strongly rotated in either direction, to assist in loosening it from the bands of adhesion which have surrounded the head of the bone. Persistence rather than great force is what is needed to obtain reduction. Although no care will remove all risk of accident, the avoidance of extreme force in traction, and the patient repetition of the rotations, will very much abate this danger as compared with that of other methods. After long-continued efforts, the surgeon may be rewarded by feeling the bone slip into place, whereas the most energetic endeavors, continued for a few moments only, would have resulted in failure.

Subcutaneous section of the capsular ligament has been proposed and practised in this, as in other joints. I believe this operation to be nearly devoid of danger, when performed with full antiseptic precautions, and recommend it always, rather than permanently leaving the shoulder hopelessly maimed.

Recent cases which prove extraordinarily obstinate may also justify the same heroic measure. In other large joints, such as the elbow, I have often had recourse to this means of facilitating reduction, and believe it to be almost as safe as tenotomy, or as aspiration of an inflamed joint. By it I have succeeded in perfectly restoring joints which had been given up as hopeless, and certainly would have been so by any other means. No case has ever come under my care in which this operation has been required in the shoulder, but I certainly should resort to it rather than leave the joint unreduced, and in preference to resection. [Subcutaneous *osteotomy* of the humerus has been successfully employed by Dr. Mears, of Philadelphia, in a case of old, unreduced humeral dislocation, attended by great pain.]

Resection of the head of the humerus is a dangerous operation, but one which may be imperatively called for in cases where the axillary plexus is so compressed as to cause paralysis, and where every other resource has been invoked. The expedient, above described, of making subcutaneous, anti-septic divisions of the soft parts with the tenotome, would probably do away with the need of exsection.

DISLOCATIONS OF THE ELBOW.

Injuries of the elbow-joint occasion many errors of diagnosis, which render it important to consider the means of distinguishing the various lesions met with in this locality. The surgeon should have clearly in mind the four landmarks of this region, which are:—

- The internal condyle.
- The external condyle.
- The olecranon process.
- The head of the radius.

These four bony points always enable the presence of a luxation to be discovered. In the systematic examination of an injured elbow, the two condyles must first be examined, the patient by preference being anæsthetized, to determine their firmness of attachment to the shaft. When no movement or crepitus can be elicited by forcible pressure, neither the condyles nor the lower end of the shaft are fractured, and the possible existence of this common form of injury is eliminated from the differential diagnosis. After fully determining that the condyles are unhurt, the olecranon process must be sought for, in a position on a line approximately halfway between the condyles. The varying length of the inner condyle makes only a slight difference in this respect.

Below the internal condyle, a depression may be felt through the muscles.

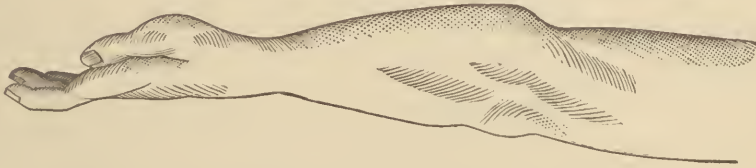
Below the external condyle, on the other hand, the surgeon should feel the fourth important landmark—the head of the radius—which may be made to rotate by turning the hand. The radial head is the most difficult of the landmarks to discover, but almost always can be identified by making firm pressure, and by rotating the forearm back and forth so as to cause the head to revolve under the fingers.

By comparison with the sound arm, it will not be difficult to settle the question of whether there has occurred any forward or lateral displacement of this bone. With the arm flexed, the olecranon should be on a line with the posterior surfaces of the humeral condyles, and, as already stated, halfway between them. A forward or backward displacement of this bony point at once arrests the notice of the surgeon, showing that he has to deal with a dislocation or a fracture.

DISLOCATION OF THE HEAD OF THE RADIUS FORWARD.—*Causes.*—Falls upon the elbow occasionally drive the head of the radius, by direct violence, into a position in front of the joint, and falls upon the hand have been said to cause the same injury. A radius has been known to be displaced forward at its upper end, simply by lifting a rather feeble child by one hand from the floor.

Symptoms.—In this accident the head of the radius is found upon the front of the humerus, where its presence is certainly proved by making rotation of the forearm while pressing with the thumb over the misplaced bone.

Fig. 563.



Forward dislocation of the head of the radius ; forearm supinated and extended.

Pressure in front of the external condyle discovers the vacuity from which the bone has departed. The forearm commonly is somewhat pronated, but may lie between pronation and supination, and may even be occasionally supinated. Some flexion usually exists, which can be increased to a right angle only. There is usually some pain and resistance when the limb is completely extended. The sudden locking of the bones which prevents the flexion beyond a right angle, occurs at the moment when the head of the radius strikes the front of the humerus. It is quite characteristic, and differs entirely from mere muscular resistance. The constant tension of the biceps muscle is the force maintaining the forward position, and the greatest obstacle to successfully retaining the bone when reduced.

Prognosis.—I have myself had no difficulty in the reduction of these cases. Sir Astley Cooper reported two failures in recent cases of his own, and some in the practice of other surgeons. Malgaigne, out of twenty-five cases, found six in which the diagnosis was not made until too late; eight in which reduction was successful; and eleven in which it failed. Hamilton met with three cases in which reduction had not been effected, and three in which, through mistaken diagnosis, no attempt at reduction had been made. One which had been treated by a member of the Sweet family of “natural bone-setters,” was a complete failure.

It will therefore be seen that the surgeon can be by no means confident of success, even with the most faithful and careful efforts.

Treatment.—In many cases simple extension upon the forearm, with pressure of the thumb upon the head of the radius, will effect reduction. This Hamilton believes to be more successful when it is made in the direction in which the limb is found to point, that is, in a semiflexed position. After reduction, the limb must be maintained in a flexed position for several weeks, so as to secure a reasonably firm union of the capsule. The arm should be placed in a sling, and the patient directed never to lift the forearm so as to bring the biceps into a state of tension, as this would tend to draw the bone from its place. An angular splint at the back or front of the arm, is of use to assist in retaining the bones. After a few weeks, cautious, passive movements should be begun to prevent too much stiffening of the elbow. The luxation is one easily reproduced for a long period afterward, on account of the conformation of the articulating surfaces. It is easily seen, therefore, that the dislocation, if found to exist, may be only a reproduction of one which has

before been successfully reduced, and that therefore no blame can attach to the surgeon in case permanent deformity results from the after treatment not having been properly carried out by the patient.

DISLOCATION OF THE HEAD OF THE RADIUS BACKWARD.—This accident is rather rare.

Causes.—Direct blows upon the front and upper end of the bone, and falls by which a similar impulse is given to it, as when a person falls upon his hand, are the usual causes of the injury.

Symptoms.—The head of the bone, as in forward luxations, can be detected in the position indicated by the description of the injury, that is, back of its normal place upon the external condyle, while over and in front of the latter, a vacancy exists, caused by the disappearance of the radial head from its articular facet.

The forearm, as in other dislocations of the elbow, is slightly flexed. It is said to incline to the prone position, and is bent more outward than natural, on account of the upward slipping of the radius, thus shortening the radial side. Flexion and extension, as well as supination, are very limited.

Treatment.—The opinions of authors are somewhat at variance as to the best means of reducing this luxation, and in fact it is not strictly necessary to pursue a uniform method. The following plan will accomplish the reduction as well as any that can be devised: Let an assistant seize the wrist and make traction, at the same time supinating the member strongly, while the surgeon with his thumbs and fingers presses the bone into position.

DISLOCATION OF THE HEAD OF THE RADIUS OUTWARD.—It is doubtful whether this dislocation ever occurs primarily, or whether it is always secondary to the anterior or posterior form. The method of reduction is by making extension upon the forearm as before, and then pressing the bone toward its place.

DISLOCATIONS OF THE UPPER END OF THE ULNA.—It is denied by some that an anterior dislocation of the ulna can ever occur without fracture of the olecranon, but one or two cases are recorded which seem veritable.

Extreme violence must be supposed to cause this injury, and the destruction of the ligaments is necessarily such that the bones may lie in almost any position. Practically, dislocations of the ulna occur in three directions, viz., backward, inward, and outward.

As to whether the ulna alone can be displaced backward, there is a good deal of contradictory testimony. The weight of evidence seems to show that in rare instances this has occurred, leaving the head of the radius still secure upon the external condyle. The treatment is in all details the same as when both bones are displaced.

DISLOCATIONS OF THE RADIUS AND ULNA BACKWARD.—The most frequent cause of this accident is found in falls upon the hand.

Symptoms.—Both radius and ulna are found back of the lower end of the humerus, so far as to allow the coronoid process of the ulna to be hooked behind the condyles, and to rest in the olecranon fossa, being drawn upward by the tension of the triceps muscle. The elbow is bent at an obtuse angle. The anterior and lateral ligaments are more or less torn, but the posterior part of the capsule is intact. The brachialis anticus and biceps muscles are often lacerated. The median nerve is often compressed, as shown by the numbness below. The ulnar nerve also is sometimes affected. As to whether the hand is pronated or supinated, authors make very contradictory statements.

Pronation is certainly more usual. There is little mobility, the bones being locked by the tension of the muscles and of the strained ligaments. The lower end of the humerus can be felt in the bend of the elbow, and the head of the radius and olecranon behind their natural position as regards the humeral condyles.

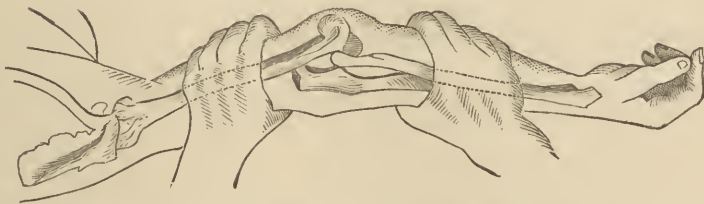
The differential diagnosis of this luxation ought not to be difficult, but it has caused many mistakes even in the hands of experienced surgeons.

From fractures of the condyles wherein the same backward projection of the olecranon may occur, this variety of luxation may be known by the fact that the condyles are seen or felt not to have gone back with the bones of the forearm, as well as by the absence of either crepitus or increased mobility. Anæsthetics may properly be employed in cases of obscure injury about the elbow, in order that a certainty of diagnosis may be arrived at, which will enable the practitioner to treat the case intelligently, and to avoid future blame for the imperfect results which occur, especially in fractures. Reduction is also easier with the aid of ether than without it.

Fracture of the coronoid process of the ulna, with backward displacement of both bones, is in fact a real dislocation complicated with fracture of the anterior border of the joint. The symptoms are the same, except as regards the presence of crepitus, and this is not always discernible; but the treatment differs in that special measures are required to prevent the bone from slipping backward again as soon as reduced. This occurrence is of itself diagnostic of fracture of the coronoid, and should be carefully looked for, and the fact determined as to whether or not there is a tendency to redisplacement.

Treatment.—Several methods of reduction are successfully practised. It is sometimes sufficient to over-extend and then suddenly flex the arm while keeping up a moderate degree of traction, as shown in the annexed illustration (Fig. 564). The older surgeons usually reduced this dislocation with

Fig. 564.



Reduction of backward dislocation of radius and ulna.

the patient in a sitting posture, by means of the knee in the elbow, as described by Sir Astley Cooper. As this would not be judicious when anæsthetics are used, this method is best modified so as to admit of keeping the patient in a horizontal position. What is desired is to place the elbow at a right angle across some fulcrum by which to pry or lift the coronoid out or back from behind the articular surface of the humerus, at the same time that extension is made upon the forearm.

Dorsey, instead of placing the knee in the bend of the elbow, had the wrist and forearm held by an assistant, while he interlocked his fingers above the elbow and drew the humerus strongly backward. Skey employed extension with the arm straight. Liston overcame muscular resistance by means of counter-extension against the scapula and backward traction on the forearm. Hamilton uses the knee, as directed by Cooper.

A modification of this method consists in placing the patient in a horizontal position, and making extension with the foot in the bend of the elbow,

the surgeon being seated at the patient's sound side, and placing his leg across the patient's breast. Anaesthesia may be employed with advantage. The foot, placed as above directed, serves for counter-extension against the force of the traction exerted by the hands grasping the forearm, and also as a sort of fulcrum, just as when the knee is used in the same way.

Ancient Dislocations.—Unreduced dislocations of the elbow become hopeless sooner than those of the shoulder. A large number become almost irreducible in six weeks. Even after this time, however, they should not be given up without trial. After nine weeks I have succeeded in effecting restoration of a luxated elbow by the use of Jarvis's adjuster, combined with subcutaneous section of the lateral ligaments under antiseptic precautions.

This resource I consider an extremely valuable one, and one also which is nearly harmless, if care be observed, in passing the tenotome, not to injure the ulnar nerve where it crosses close to the internal lateral ligament; with no possible harm, great assistance may be rendered by dividing the tendon of the triceps. Forced flexion and other movements also assist in breaking up adhesions.

DISLOCATION OF THE RADIUS AND ULNA OUTWARD.—Lateral dislocations at the elbow-joint are usually incomplete, though in some very severe injuries, both bones of the forearm are completely luxated, and may be found lying upon the side of the humerus, producing great deformity. When the bones are thrown toward the radial side, or outward, the study of the landmarks shows the olecranon to be removed too far from the inner, and to be placed too near the external condyle.

The radius is also thrust too far outward, and the cuplike cavity of its head can be felt with the fingers through the integument. The arm is somewhat flexed, because the olecranon, being carried away from its fossa, strikes the back of the external condyle, and prevents full extension.

The inner condyle is too prominent, and the depression in front of it more marked than usual. The diagnosis from fracture must rest mainly upon the absence of crepitus, and upon the immobility of the various bony parts.

DISLOCATION OF BOTH BONES INWARD.—Very few cases of this kind have been recorded. The head of the ulna rests in the hollow between the internal condyle and the trochlear eminence of the humerus. The deformity is not conspicuous, and this dislocation is often overlooked on account of the long, projecting internal condyle concealing by its prominence the misplaced ulna.

Careful study of the four landmarks at once shows the same condition of affairs as that already described in the outward form, only reversing the directions there named. The olecranon is much too near the inner condyle.

Treatment.—Extension of the forearm is made by assistants, while the surgeon presses upon the bones in order to coapt them. The reduction is easy, and little tendency is found to the reproduction of the luxation.

DISLOCATION OF THE RADIUS AND ULNA IN OPPOSITE DIRECTIONS.—Dislocation of the radius forward and of the ulna backward, is an injury of which at least four or five cases have been recorded. Traction and pressure upon the ends of the bones should be employed, as has been directed for each luxation. One or both bones may in this manner be reduced.

COMPOUND DISLOCATIONS AT THE ELBOW.—These are grave and sometimes fatal injuries. More conservative treatment is, however, justifiable here than in the ankle-joint or knee, because the danger to life is less. Prompt closure of the external wound, with full antiseptic treatment, may even secure a reco-

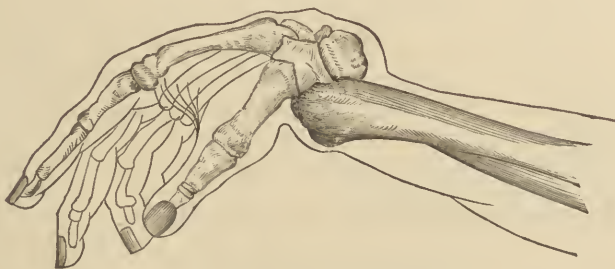
very without ankylosis, but this must always be exceptional. Amputation is seldom or never called for in these cases, but primary excision of the joint will often be the best course. This must depend upon the amount of injury which has been done to the bony structures, to a great extent, but somewhat on the extent of laceration of the soft parts as well.

DISLOCATIONS AT THE WRIST.

DISLOCATION OF THE CARPUS.—The older surgeons considered this accident extremely common; but modern investigations of the fractures at the lower end of the radius, have shown dislocation to be much less frequent than was once supposed. These luxations occur either backward or forward.

The *backward dislocation* is produced by violent flexing of the hand, or by blows or falls on the back of the hand while it is thus flexed. The carpus

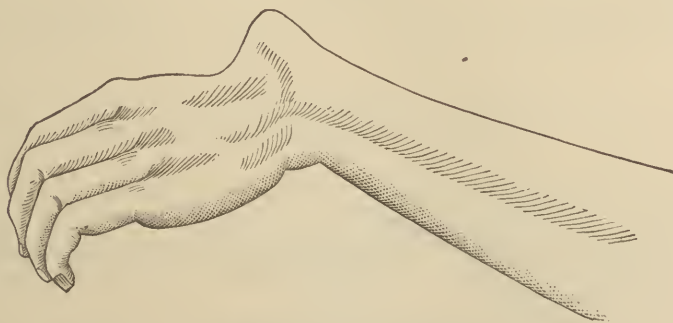
Fig. 565.



Backward dislocation of carpus.

is forced upward and backward upon the radius and ulna, while the latter make a large prominence in front of the wrist. Fracture of the rim of the joint often accompanies this injury. The chief danger in diagnosis is in confounding this luxation with fracture of the lower end of the radius. The mobility of the styloid process, even if crepitus be wanting, will usually

Fig. 566.



Forward dislocation of carpus.

make the differential diagnosis absolute. Where the radius is broken obliquely, so as to leave the styloid process attached to the shaft, the diagnosis must rest largely upon the presence of crepitus.

The *forward dislocation* presents a great prominence of the bones of the

forearm behind the wrist, and resembles in general causation and pathology the last-mentioned luxation, except as to the direction of the displacement.

Dislocations at the wrist are reduced without great difficulty by making traction upon the hand and pressing the bones toward their places with the thumbs and fingers. As in other joints, compound dislocations should be treated antiseptically. Excision, rather than amputation, should be preferred in these cases.

DISLOCATIONS OF THE LOWER EXTREMITY OF THE ULNA.—Luxations occur in which the lower end of the ulna is thrown decidedly forward or backward without the radius participating in the displacement. The causes in the few cases cited seem to have been various, including falls, muscular action alone, and, in several cases, simple extension, as by lifting the weight of the body by the hands. The fibro-cartilage is ruptured, and the extremity of the bone is thrown in front of or behind the radius, as the case may be, making either the forward or the backward luxation. The treatment consists simply in pressing the bones into place, in the forward form supinating the hand, and in the backward pronating it, to assist the replacement.

It is said by Moore, of Rochester, that the styloid process of the ulna sometimes becomes engaged under the annular ligament, so as to resist the reduction. He advises strongly to flex the hand, and abduct it also toward the radial side, in order to unlock the styloid process. If it cannot be so disentangled in cases where it is held in this way, a careful section of the border of the ligament with a tenotome, and under full antiseptic precautions, will be justifiable.

This injury very commonly is accompanied by fracture. The displacement of the fragments may prevent reduction in such cases, and if the deformity appear slight, it may be neglected, especially in cases of impaction, wherein it seems important not to dislodge the bone. If the deformity be very great, then the risk must be taken of dislodging the impaction. Anterior and posterior splints, with suitable compresses, may be used to retain the bone for several weeks after reduction.

DISLOCATIONS BETWEEN THE BONES OF THE CARPUS.—These are rare, obscure, and meagerly described. Undoubted cases of dislocation of a single bone have, however, occurred. When found in time, such cases are to be treated by direct pressure, and such position of the hand as experiment shows to favor retention. Compresses and splints to maintain immobility are requisite in the after-treatment.

DISLOCATIONS OF THE HAND.

DISLOCATIONS OF THE METACARPAL BONES.—The metacarpal bones are not often dislocated, that of the thumb being the only luxation at all frequent, and this only relatively so, as all forms are rare. The metacarpal bone of the thumb may be displaced either forward or backward from its articulating surface on the trapezium.

In the *backward* form of dislocation, the cause seems to have been extreme flexion, or the infliction of blows upon the extremity of the thumb, driving it back while flexed.

Reduction should be effected by extension upon the thumb, combining this with direct pressure upon the bone itself in the direction of its articular surface.

In *forward* dislocation, the thumb will be found to present a vacuity at the

place of the joint, and a prominence in front. It is bent backward, and cannot be brought over to the little finger. Reduction is said by Cooper to be more difficult than in the last form. It should be attempted in the same manner, except that the thumb may be brought over toward the palm, to relax the powerful flexor muscles. The traction should be long continued and persistent.

Recourse may be had to the tenotome in making section of the lateral ligaments, but no division of the tendons is advisable or beneficial.

DISLOCATIONS OF THE METACARPAL BONES OF THE FINGERS.—These are usually produced by blows given with the clenched fist, and the displacement is only partial. Whether in a backward or forward direction, the reduction is accomplished by making strong extension on the affected finger, and by pressing upon the prominence caused by the head of the bone.

DISLOCATIONS OF THE PHALANXES OF THE THUMB AND FINGERS.—The usual direction of these displacements is backward, but forward luxations also occur. It is, in some instances, surprisingly difficult to reduce dislocations of these small joints, one difficulty evidently lying in the fact that the shortness of the fingers does not furnish sufficient hold and leverage for manipulation and traction. There is, however, some difference of opinion as to the main cause of this difficulty of reduction. It may be partly explained as follows: the proximal phalanx of the thumb, for example, being displaced backward, the sharp anterior ridge of the base of the phalanx rests just behind the terminal enlargement of the extremity of the metacarpal, held firmly in this position by the tightly strained, lateral ligaments. Extension tends only to put these ligaments more violently upon the stretch, unless proper manipulations are employed to release the bone. When in a semiflexed position, extension tends only to draw the member more nearly straight, and hence only increases the resistance, as the phalanx comes more nearly into a line with the metacarpal bone. But the strong lateral ligaments, acting as a fulcrum, increase the pressure of the two bones, which thus become more and more firmly locked. Hence the dislocation cannot yield to any amount of extension, unless it be applied in a suitable direction.

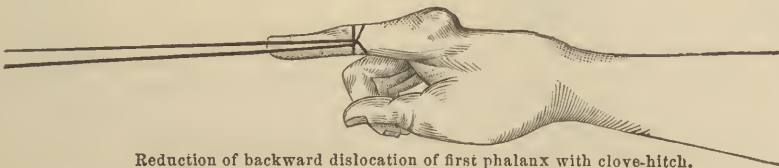
Considerable force must be employed, in whatever direction it be made, and to obtain this, a clove-hitch, Jarvis's adjuster, the "Indian puzzle," and

Fig. 567.



Forward dislocation of second phalanx of finger.

Fig. 568.



Reduction of backward dislocation of first phalanx with clove-hitch.

other appliances, are called into use. It is to be remembered that too great force may cause a stripping of the skin from the thumb or finger, while using any of the mechanical aids in traction.

In attempting reduction, the first efforts may be made by grasping the

member, and making extension in a straight position. Some cases are readily reduced by this simple means. Failing in this, extension may be tried in the flexed position, and by the aid of to and fro movements or rocking of the joint.

A band may be attached to the member by a clove-hitch if more force is desired, and any amount of additional power of traction thus obtained. After the tissues have been somewhat stretched, the effort may again be made to push the two bones into apposition. For this, the right-angled position is the most favorable, as it prevents, to some extent, the locking of the bones upon each other.

If this fail, the opposite manœuvre of forcibly straightening the phalanx may be resorted to; or strong backward flexion even may be attempted, in which position traction in a reversed direction may be applied, the thumb or finger being at the same time brought slowly around to a straight position.

When all other methods fail, subcutaneous division of the lateral ligament upon one or both sides, with perhaps section of the flexor brevis pollicis under antiseptic precautions, is justifiable, and rather than leave the deformity, the surgeon should adopt this operation, which is warranted by both reason and experience.

DISLOCATIONS OF THE HIP.

The opinions and practice of surgeons in respect to dislocations of the hip have undergone great changes during the past few years, in consequence of investigations connected with the subject of reduction by manipulation. These investigations have been carried on chiefly by Professor Henry J. Bigelow, of Boston, who has courteously allowed the use of several illustrations from his excellent monograph on the subject.¹ It will not be possible, in the space assigned to the subject in this work, to give an elaborate discussion of the various conflicting opinions which in times past have been put forth by eminent writers; but it is safe to assert that, at the present time, the highest authorities in the profession are agreed, in the main, as to the truth of the statements which are about to be made.

ANATOMY OF THE HIP-JOINT.—There are two principal agents whose action confers upon a dislocated hip-joint the characteristic features by which the accident is recognized, and which also constitute the chief obstacles to reduction. These agents are, first, the untorn portion of the capsular ligament, and, secondly, the obturator internus muscle and tendon. The other muscles surrounding the hip have a certain influence, but experiments show that when they all are cut away, with the exception of the obturator internus, the characteristic features of the dislocation still remain, and the difficulties of reduction are not removed.

The *capsular ligament*—arising from the circumference of the acetabulum and parts adjacent—is inserted near the junction of the neck of the femur with the trochanter. It is, therefore, a tubular structure, complete in its entire circumference, but very much thicker at certain exposed points than at others. As the most frequent tendency to dislocation would naturally be upward, the superior part of this fibrous tube is always thicker and stronger than the part below. Other parts are also greatly thickened for certain purposes of security. From the anterior superior spinous process of the ilium, and from the bone below as far as the border of the acetabulum, arises a mass of ligamentous

¹ The Mechanism of Dislocation and Fracture of the Hip, etc. Philadelphia, 1869.

tissue, constituting a great thickening of the capsule at that point. This powerful band terminates very abruptly in front, where its border stands out almost as if it were a separate ligament. The posterior border is much less distinct, unless it be defined by cutting into its substance with a scalpel for purposes of demonstration. Instead of terminating by an abrupt line, it loses itself imperceptibly in the thick, strong substance of the superior and posterior portion of the capsular ligament. The strong band of fibres thus defined, passes downward in front of the neck and head of the femur, toward the trochanter major, near to which it shows a tendency to divide into two branches—an internal and an external termination. The former is inserted into the anterior and superior parts of the trochanter; the latter, passing more directly downward, is inserted into the bone nearer the lesser trochanter. The space between these branches is usually not absolutely void, but filled by a thinner part of the band. Still, when the whole ligament is laid bare, and when its borders have been defined with the knife, it may be supposed to bear a likeness to an inverted letter Y, and, accordingly, from this vague resemblance, has been called by Professor Bigelow the “Y” ligament; a name which, on account of its common acceptance, it is convenient to retain. This band has also been described by other anatomists and surgeons. It has been termed the “ilio-femoral ligament,” and sometimes “Bertin’s ligament.” It is a portion of the capsular wall, of great thickness, often a quarter of an inch or more.

Fig. 569.



The Y ligament. (Bigelow.)

Fig. 570.



Showing relations of the obturator internus muscle to the hip-joint. (Bigelow.)

It is usual to describe four regular dislocations of the hip-joint, two of which are backward and two forward. In all of these the Y ligament remains untor, whatever laceration may be produced in the rest of the capsule. By its tension this ligament determines the characteristic position of the various

forms of dislocation, such as flexion, inversion, eversion, adduction, or abduction of the limb.

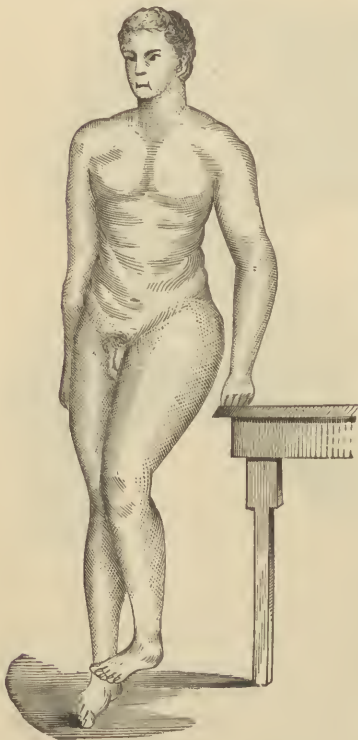
The *obturator internus* muscle has an important relation to the pathology, and also to the treatment of a certain class of dislocations. This muscle, from its origin in the obturator membrane and bony borders of the foramen, within the pelvis, converges its fibres into a tendon, which passes to the lesser sciatic notch and winds around a trochlear surface, to be inserted into the digital fossa on the great trochanter of the femur. The position of this muscle and ligament is such in relation to the displaced head of the thigh-bone, in certain cases of backward dislocation, that special manœuvres, which will hereafter be described, must, under these circumstances, be employed before the surgeon can hope to obtain reduction.

The four regular dislocations constitute those which alone are commonly met with, but in a few rare cases the Υ ligament is so nearly sundered by the severity of the accident, that the limb ceases to fall into its normal characteristic positions, and assumes various accidental and irregular postures, hereafter to be noticed.

The tendency of surgical opinion at the present time is to look upon the untorn portions of the capsular ligament as constituting the chief source of resistance to reduction, and to attach far less importance than formerly to the more yielding and elastic resistance made by the muscles.

I. DISLOCATION UPON THE DORSUM OF THE ILIUM.—This dislocation usually occurs as a consequence of force driving the femur upward and backward at a moment when it is in a flexed and adducted position. Reported cases show that falls, when the thigh is flexed and the patient strikes upon the knee, and violent compression in the same position, as when heavy bodies strike upon the back or hips of a person who is bent forward, are the usual causes of this dislocation.

Fig. 571.



Dislocation upon the dorsum ilii.

Reported cases show that falls, when the thigh is flexed and the patient strikes upon the knee, and violent compression in the same position, as when heavy bodies strike upon the back or hips of a person who is bent forward, are the usual causes of this dislocation.

With the thigh in a state of flexion and adduction, any force acting in the direction of the axis of the femur is not received upon the firm support of the acetabulum, as much as upon the thin posterior wall of the joint-tube and ligamentum teres. Both ligaments are ruptured, and the head of the femur slips over the rim of the cotyloid ligament, and glides back and up under the gluteal muscles upon the dorsum of the ilium. While the head of the femur is forced back of its normal plane, it can only reach this position through the rotation of the shaft of the bone upon its axis, as the trochanter is held rigidly forward by the ilio-femoral or Υ ligament. The thigh is, therefore, rotated inward and firmly held in this position until the dislocation is reduced. The head of the bone having gone backward, the knee is of necessity thrown forward, to some extent, by the bony conformation and by the unyielding Υ ligament. This elevation of the knee is slight—only a few degrees above the normal plane—

but constantly present, and complete extension is as impossible as outward rotation. When the knee is forced downward, the pelvis tilts backward in a corresponding angle, so that, when the patient is laid upon a hard mattress, it will always be found impossible to bring his popliteal space and loins upon the bed at the same time. The limb is also adducted, and laid across the other, so that the great toe of the affected side points toward the instep of the opposite foot. It will be found impossible to evert or rotate the limb in any direction, for the tension of the Υ ligament holds the trochanter so firmly against the pelvic bone that nothing short of rupturing its fibres or fracturing the femoral neck will allow the bone to rotate. In examining suspected cases of this dislocation, it is to be remembered that the capsules of the ankle and knee-joints in some individuals are quite loose, and permit the leg or foot to rotate through some degrees, while the thigh bone remains immovable. As already stated, the thigh cannot be abducted, nor even extended fully, save by a difficult tipping down of the pelvis, but adduction is easier, and flexion is most easy, because these movements do not tighten the Υ ligament, but relax its tension.

The thigh, from knee-pan to ilium, is of course shortened by precisely the amount of upward slipping of the head along the pelvic bone. Sir Astley Cooper says that three inches, in many cases, is the measure of the difference of the two limbs. Writers give the usual amount of shortening as much less than this. Chelius, Miller, and Malgaigne, are of the opinion that cases occur in which no shortening is to be detected. Such cases cannot be examples of upward, but only of backward luxation. Hamilton, whose authority is great in this matter, concludes that the average of shortening is not more than one or one and a half inches, but concedes that occasionally it may reach three inches, as Sir Astley Cooper believed.

The *diagnosis* of upward and backward luxations of the thigh should present no insuperable difficulty if full opportunity be allowed for investigation. For the examination, the part should be thoroughly exposed, and the patient may be placed in a variety of positions while efforts are made to test the mobility of the limb and to obtain its measurements. The differential diagnosis is not perplexing when the history of the case is known.

Fracture of the neck of the femur presents only a part of the symptoms of dislocation, yet might be mistaken for it without careful examination. Crepitus, which would prove fracture to exist, may not be present, or, in case of impacted fracture in the cancellated structure, it may be deemed highly essential not to dislodge the impaction. Shortening usually occurs in fracture of the neck, but not so uniformly nor to so great a degree as in upward luxation. The diagnostic difference in the symptoms lies in the different position and mobility of the limb in the two cases. No simple fracture of the neck can give the distinctive position and behavior of this dislocation, viz., inward rotation, flexion, and adduction, with inability to rotate outward or abduct the limb. On the contrary, the foot is commonly everted and the limb in full extension. The thigh can be moved in all directions, with no resistance other than that caused by muscular opposition on account of pain. Fractures of the femoral neck occur in old persons, as a result of sudden falls or missteps—much slighter injuries than those required to produce dislocation.

Displacements upon the dorsum of the ilium occur frequently as a result of hip-disease. In the great majority of so-called spontaneous luxations, the real anatomical change consists in almost total destruction of both the acetabulum and the head of the femur, so that the joint proper is no longer in existence. It is scarcely proper to term these cases of dislocation. They are rather instances of upward and backward slipping of the shaft of the bone, following the destruction of the joint by ulceration. From hip-disease,

there ought to be no possible uncertainty in distinguishing the traumatic luxation, by the history and symptoms as given above. I have known cases, however, in which the displacement of hip-disease in the third stage occurred in such a fashion as might have led to mistake in diagnosis, had no inquiry been made as to the previous soundness of the limb.

A boy of scrofulous diathesis entered Mercy Hospital with chronic morbus coxarius in the third stage, the hip and thigh being much distended by a purulent accumulation, but the bone not yet having been displaced, nor the limb shortened. Incision and evacuation of the abscess with probable exsection of the hip were advised, and the operation was set for the following day. During the night, without any external violence, and without attracting the attention of patient or attendant, the femur slipped quietly from its normal position, and in the morning presented to the house-surgeon the usual aspect of dislocation upon the dorsum ilii. Upon exploring the abscess, the head of the femur was found to have its upper side diseased, but its greater part was still covered with cartilage. It lay on the dorsum ilii as in a dislocation, having escaped from its socket through an ulcerated notch in the rim, of only sufficient breadth to allow its displacement. The operation was completed by exsecting the joint, and was followed by a good recovery.

A case of hip-disease such as that above related, as closely simulates one of traumatic luxation as any that occurs, there being no external sinus, and the displacement being sudden; yet it would seem unnecessary to warn a careful surgeon against the possibility of mistaking the two affections, were it not that a number of cases are on record in which this very mistake has been made.

Dislocation into the Sciatic Notch.—Some authors speak of a dislocation almost directly backward into the sciatic notch, but all backward dislocations above the tendon of the obturator internus, are in reality but of a single species. Their pathology and symptoms are essentially similar, and they ought not to be separately described on account of mere differences in degree of shortening, adduction, or inversion of the foot. On the other hand, dislocations of the head of the femur below the tendon of the obturator internus, have been shown by Bigelow to be specifically distinct from other backward displacements, in reference to both pathology and treatment, since the tendon of this muscle, being wound tightly across the femoral neck at its inner surface, makes a peculiar obstacle to reduction. This form of luxation will be separately considered.

Treatment of Upward and Backward Dislocations.—The treatment of all the backward or dorsal luxations above the obturator tendon, is virtually the same. It may be noted that, in this particular dislocation, the methods of reduction in vogue in Cooper's day have practically become obsolete during the last decade, through the development of the manipulation method.

The revival and perfection of this method of reduction in hip-dislocations, is an interesting illustration of the value of exact pathological knowledge. Reduction by manipulation had been practised in a haphazard way for ages, without having attained the requisite degree of perfection, in any special class of luxations, to supersede the traction method. Its study and its rules of procedure were so purely empirical and so often unreliable, that no great value was attached to them, although in some cases they were identical with the precise methods which modern investigation has shown to be most successful.

In the hip, the basis of the system is the knowledge of the Y ligament in its relative position to the head and neck of the thigh-bone, in their several situations after dislocation. The various flexions, rotations, abductions, or adductions of the thigh, by which the head of the femur may be moved without encountering the unyielding resistance of this ligament, or may be

disengaged from its grasp, constitute the details of the method. When the thigh is flexed upon the body, the front half of the capsule, that is, the *Y* ligament, is never tense. In any other position it is tightly drawn, and from the distance of its attachment from the centre of motion, is not easily overcome, even with the long leverage of the femur. Unless the thigh be flexed, therefore, enormous force is demanded before reduction becomes possible, but when the hip is bent, mobility is restored, and the head slips easily into its socket, often with no more traction than will lift the weight of the limb.

As already stated, this process had been observed many times, and certain procedures for favoring it had been described, but the method had not been able to supplant the pulleys, until by the exhaustive study of Bigelow it was reduced to complete rules, and given to the profession in its present, perfect form.

The present generation did not originate this idea. On the contrary, it is of very great antiquity.

Hippocrates¹ says:—

“In some” dislocations “the thigh is reduced with no preparation, with slight extension, directed by the hands, and with slight movement; and in some the reduction is effected by bending the limb at the joint, and making rotation.”

It is not until the year 1676 that we find anything further in this direction, when Richard Wiseman² said—

“If the thigh-bone be luxated inward, and the patient young, and of a tender constitution, it may be reduced by the hand of the surgeon, viz: he must lay one hand upon the thigh, and the other upon the patient’s leg; and having somewhat extended it towards the sound leg, he suddenly must force the knee up towards the belly, and press back the head of the *femur* into its *acetabulum*, and it will knap in; for there is no need of so great extension in this kind of luxation.”

In 1713, similar ideas were advanced by Richard Boulton, probably taken from Wiseman.³ In 1742, three dislocations of the hip-joint were reported as reduced by manipulation by Daniel Turner.⁴ He commenced by extending the limb in the old way, and then directed a sudden flexion.

“So soon as the surgeon perceives the bone moving out, let him take his opportunity, giving orders to the extenders below, suddenly to lift up the patient’s thigh towards his belly, pressing with his hands either to the right or left, as the situation of the same requires, and therewith force back its head towards the *acetabulum* whereunto it will . . . snap sometimes with a loud noise.”

In 1772, Thomas Anderson, a surgeon of Leith, Scotland,⁵ commenced to practise a method of manipulation strictly in accordance with modern theories, and reported several successful cases. Anderson, not recognizing the action of the ligament, said that he became convinced that the extended position was faulty because of the tension which it produced in the muscles. He averred that by bringing the thigh to nearly a right angle with the trunk, the muscles were relaxed and reduction made easy. He made the necessary extension with the limb bent at the hip-joint. Adducting it, he then drew it with a rotary movement across the opposite limb, thus accomplishing reduction with very little force.

¹ Genuine Works. Sydenham Society’s Translation, vol. ii. p. 643.

² Eight Chirurgical Treatises. Book VII. chap. viii.

³ System of Rational and Practical Surgery, p. 346.

⁴ Art of Surgery. London, 1742, vol. ii. p. 339.

⁵ Medical and Philosophical Commentaries. By a society in Edinburgh. Vol. iii. p. 424, London, 1775.

Pouteau, whose works were edited after his death by Vidal (de Cassis),¹ put on record his opinion that the thigh ought to be flexed to a right angle during the time that extension was made, and rotated when it was believed to be sufficiently extended. This, he thought, relaxed the opposing muscles, which, in his day, were considered the chief agents in resisting reduction.

In 1811, Dr. Physick² reduced a dislocation at the hip by flexing the thigh to a right angle and giving the limb a circular sweep, probably much after the manner of Reid, of Rochester. In 1815, Nathan Smith, of the New Haven Medical College, taught that the thigh should be flexed back upon the pelvis and the leg back upon the thigh, and the thigh carried diagonally to the opposite side, whence it was to be swept outward and downward. He also expressed the opinion that the pulleys and other mechanical sources of power were not necessary in reducing dislocations. This he taught for many years, but he does not seem to have published his views. His son, Dr. Nathan R. Smith, of Baltimore, however, explained his father's methods, fully and clearly.³ In 1820, Dr. Howe, of Boston, a pupil of Nathan Smith, advocated similar methods and used them in his practice.⁴

In the early half of this century more than a dozen different surgeons in various parts of the world reported successes by analogous methods. Yet the literature of the subject was in a very confused and disjointed condition, and attracted little attention at large in the profession.

In 1851, Dr. W. W. Reid, of Rochester, described three cases of dislocation of the head of the femur upon the dorsum of the ilium, and accompanied his paper with so accurate a description of his method that other surgeons were able to repeat the manipulation. This paper attracted great attention, and many of the profession assumed that Dr. Reid was the inventor of the method, so that by some it was termed "Reid's method."

About this time, Prof. Bigelow, of Boston, commenced a course of investigation which was pursued through a series of years, by the aid of careful dissections and experiments upon the cadaver. In 1869 he published his work "The Mechanism of Dislocations and Fractures of the Hip, with the Reduction of Dislocations by the Flexion Method." In this work the whole subject is thoroughly discussed, including the relation of the mechanism of the joint to the movements of manipulation. He placed the whole subject in such system and order that the extension methods soon became obsolete. All the methods of reduction by manipulation are reducible to two, viz. traction and rotation.

(1) *Traction*.—In this method the operator, with a dorsal dislocation, grasps the lower part of the leg in one hand, and flexes the limb both at the knee and hip, nearly to a right angle, at the same time laying the other hand upon the knee to assist in the movement. The thigh is then adducted and slightly rotated inward, using the leverage of the leg to make rotation. This important step, therefore, consists in carrying the knee and the foot in opposite directions—the knee toward the sound limb, the foot away from it. Thus the head of the femur is lifted out from behind the rim of the acetabulum, and at the same time, by the inward rotation of the top of the femur and trochanter, the Y ligament is completely relaxed. The situation is now favorable for easy reduction by very slight traction, only enough force being in general applied to raise the weight of the limb, and to lay the head of the

¹ Œuvres Posthumes de Pouteau. Paris, 1783.

² Dorsey's Surgery, 1813, vol. i. p. 242.

³ Medical and Surgical Memoirs, by Nathan Smith, M.D., edited by N. R. Smith, M.D., p. 163, Baltimore, 1831; Transactions of the New York State Medical Society, 1856, p. 169; Transactions of the New Hampshire State Medical Society, 1854, p. 55.

⁴ Boston Medical and Surgical Journal, May, 1840.

bone in its socket, to which the previous manipulations have made the way clear for its entrance. The thigh is now directed nearly perpendicularly to the plane of the body, and is laid somewhat across the sound limb, with the foot drawn outward, away from the median line, by the hand, which grasps the ankle. Let it be remembered that however simple each step of the manipulation may seem, it is absolutely essential to the success of the procedure. If with the limb thus flexed, adducted, and rotated inward, gentle traction now be made, the head of the bone will come into a position directly over the acetabulum, and be ready to glide into its socket. But it is not yet reduced. The rest of the manipulations are as essential to success as any which have preceded them. A false move would throw the head again upon the ilium, but the right one will replace it. To insure this, the movements given the limb are exactly the counterpart of those which have preceded them.

By one rapid movement the surgeon abducts, rotates outward, and extends the limb, or, in other words, carries the knee outward and the foot inward, and lays the limb upon the bed. Reduction is accomplished. The ease with which this takes place is surprisingly in contrast with the enormous force required to reduce a luxated hip by traction in the extended position. Sometimes more resistance is encountered than merely enough to lift the limb, but it is never great. This difference depends mainly upon the size in the rent which has been made through the capsule. Occasionally this is so small as of itself to make some resistance to the head of the bone in its return. In that step of the manipulation, where traction is required, it may be effected by the hand of the surgeon placed behind the knee, drawing gently in the direction of the axis of the femur, or by giving the limb a forcible jerk upward toward the ceiling; or the operator may obtain a still stronger pull upon it by hooking his elbow below the knee. In case the first attempt fails, the manipulation may be repeated, slightly varying the angles of flexion and adduction. The attempt may be repeated several times, and it usually effects a reduction if persisted in, if not at the first attempt.

Where greater traction is required in the estimation of the surgeon, greater force may be obtained by the following plan: Removing his shoe, let him place his foot upon some firm point, such as the anterior superior iliac-spine, or the pubis, to give opportunity for counter-extension, and to steady the pelvis while the traction is being made. The steps of the manipulation are then to be taken precisely as before, except as to the changed position of the surgeon in grasping the limb. Instead of relying upon his hands alone, the operator may employ a jack-towel from the thigh around his shoulders, leaving only the twisting and other movements to the hands, while the pull is exerted by leaning backwards. It is only in rare cases that anything more than the unaided hands is required in the traction method of manipulation. Before resorting to more force, the manipulation should be repeated with thoroughness to make certain that the trouble does not lie in its faulty execution, rather than in the need of more powerful extension.

Every pure dorsal luxation could probably be reduced by the simple method first described, were surgeons not too hasty in giving up the trial. Where it does fail from wrong execution or any cause, it is better not to increase the traction enormously—which would be, in fact, a return to the obsolete methods—but to make use of the other form of manipulation, the rotation method, which will be described presently. This will furnish power enough to reduce the bone with unfailing certainty.

Should it be determined to employ more force in traction, however, this must be obtained without recourse to the pulleys, or any mechanical aid requiring a fixed attachment. These prevent flexion and adduction. A strip

of wood may be passed beneath the calf of the leg, transversely, and held in the hands of two assistants under the surgeon's direction, while he himself grasps the knee and ankle, using the leg as a crank by which to make rotation of the thigh. The limb is thus in very complete and powerful control, and yet at perfect liberty to be submitted to the desired motions. With the pulleys, manipulation is impossible. Another plan by which the same effect may be secured, consists in placing the patient face downward upon a table, with his thighs hanging at right angles to his trunk, over the edge, and with a folded quilt laid under his pelvis. Seizing the ankle of the dislocated limb with one hand, and placing the palm of the other, or the sole of his foot, in the bend of the knee, the surgeon is able to make the usual flexion, adduction, and extension, together with an amount of traction equal to his own weight.

Still more power may be obtained by means of Jarvis's adjuster, which permits the manipulations to be made as usual, together with any amount of traction which the surgeon may deem desirable. This instrument, on account of the movements which it permits, is far superior to the pulleys, but as it is not in the hands of many surgeons at the present time, and will frequently not be attainable in emergencies, or in remote places, some extemporaneous substitute is needed. For this purpose it is best not to resort to extension from a fixed point, but to make an extemporaneous adjuster, by which the force can be exerted in just the needed directions, which can be quickly changed as desired.

A bar of wood about five feet in length—a bed slat will answer—is to be secured by a notch or hole in one extremity to a large towel or sheet passed about the perineum. This furnishes counter-extension from the pelvis. From the lower part of the thigh, a stout bed-cord, attached by a clove-hitch, passes to the other extremity of the wooden bar, and is attached to a small cleat of wood. By means of twisting the two cords, or, better still, by the Spanish windlass, an enormous degree of traction may be made upon the thigh, while at the same time the limb is under complete control for rotation or other movements. Care must be taken in using either the Jarvis's or the extemporaneous adjuster, that too great force is not exerted unawares. These mechanical aids are seldom needed in the reduction of this form of luxation, and the pulleys never. Let them be considered obsolete in the management of these cases.

The rotation method offers a more certain and less violent means of reducing hip-dislocations, where the traction method fails. One cause of difficulty in the latter, is probably the small size of the rent which has been made in the capsular envelope, resisting the return of the large head of the femur into its socket. In such cases, no manipulation will cause it to return until this rent has been enlarged. The idea of a mechanical rending of the capsule need not appal the surgeon. It is an operation free from danger.

To accomplish this, the thigh should be flexed until it nearly touches the abdomen, when, the pelvis being steadied by an assistant, the knee is carried forcibly outward until the thigh, still sharply flexed, stands outward at a considerable angle from the body. This causes the neck of the femur to sweep laterally across the posterior and lower part of the capsule, tearing its fibres and enlarging the rent made by the head in its exit. Occasionally it occurs that this manipulation effects the reduction. Should this chance to occur, it will be discovered, upon extending the limb preparatory to new attempts. After this manœuvre, the traction method generally will effect reduction with comparative ease by the manipulations already described.

When it has been successful, the limb no longer lies over upon the other, inwardly rotated and stiffly resisting all attempts at abduction and complete

extension, but the popliteal space is down upon the table, the limb is movable in all directions, and the toes turn outward in a natural manner. Grasping the foot, it is found that rotation is possible.

(2) *Rotation Method*.—The method above described is preferable to the other form of manipulation, termed by Bigelow "rotation," because it effects reduction with the least possible injury to the tissues about the joint. Rotation is more violent, but more effective.

The *modus operandi* is as follows: laying one hand upon the knee, to guide its motions, the surgeon grasps the ankle with the other, and flexes the leg upon the thigh, and the thigh upon the abdomen, as far as possible. It is well to have the pelvis steadied by the hands of one or more assistants grasping the ale of the ilia.

With the limb in this position, let it now be inverted, that is, rotated inward. This causes the head of the bone to ride well away from the back of the ilium, so that it is unlocked from behind the acetabulum. Instead of traction, as in the last method, rotation is now made by sweeping the knee, still kept well down upon the body, transversely outward to an angle of 45° or more. It should be carried outward in this manner to a point where considerable elastic resistance is felt to its further progress. The Υ ligament, by this process, is converted into a fulcrum, to make the head of the femur pass inward toward the acetabulum. The last step of the manipulation consists in a quick movement by which the leg is straightened once more in a line with the body. This is done by holding the limb well abducted, carrying the foot and knee downward to full extension, and slightly rotating outward to cause the head of the bone to be thrown inward to its socket. The limb will be seen to be reduced.

It is important that the downward sweep at the close of the manipulation should be forcibly and somewhat suddenly made, the knee being held strongly out by one hand, while the hand upon the ankle gives the rotary motion, the whole being simultaneous. There should be no pause between the outward and the downward sweeps, which for clearness we have described as separate steps. The succession is instantaneous, so that the two steps consist in reality of but one bold movement, beginning with the outward sweep, and passing so suddenly into the downward, that the knee is not observed at any instant to be at a standstill, or "dead point" of motion. Firm and quick handling is essential to the whole manipulation. Too slow or too yielding a touch will allow the head of the bone, at some stage of the manipulation where it is poised ready to re-enter its socket, to slip backward, instead of forward into place.

To assist the memory, the description of the manipulation may be condensed into the following terse directions: *Lift up; bend out; roll out.*

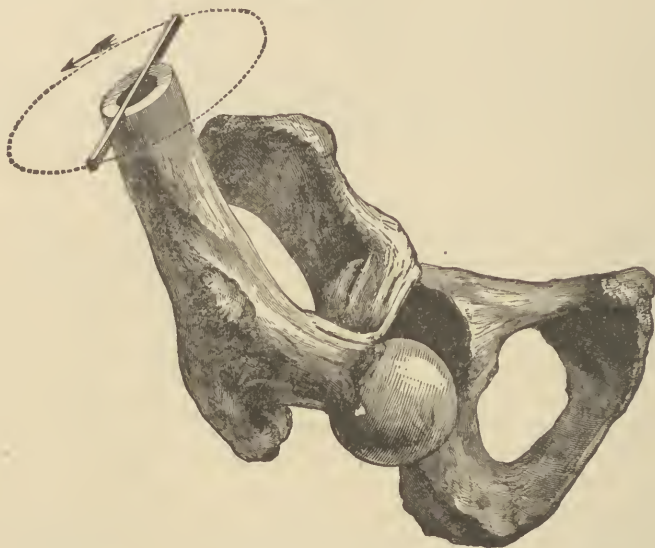
This is the process of hip-reduction once known as "Reid's method." It is very powerful, and has reduced many obstinate dislocations, and some of long standing.

According to Prof. Bigelow, the manipulation will be more certainly successful, if, at the moment when the downward sweep is made, the limb is also jerked sharply upward toward the ceiling. The traction principle would thus be added to that of the rotation method. Upon anatomical grounds the recommendation would seem a good one, but at present it lacks the confirmation of other surgeons' experience.

The energy of the rotation method is very great, and it is usually advisable to first attempt reduction by the milder traction method, reserving the other for obstinate cases. Some idea of its power may be gained from the fact that it has been known to throw the head of the bone beyond its socket, entirely across and through the opposite side of the capsular ligament, so as

to convert the injury into a forward dislocation. I have repeatedly seen this in experimenting upon the cadaver with the rotation method, but not with the traction manipulation, and I do not believe it possible with the latter.

Fig. 572.



Mechanism of reduction of dorsal dislocation by rotation. (Bigelow.)

II. BACKWARD DISLOCATION BELOW THE TENDON OF THE OBTURATOR INTERNUS.

—The dislocation described by Sir Astley Cooper as occurring directly backward into the sciatic notch, probably does not exist as in any way clearly distinct from other backward dislocations in general. Among these it is true that there are variations in direction and in the amount of displacement, but not differences of kind. Their general symptoms are alike, and their proper treatment identical, and they should therefore be regarded as belonging to a single species in any clinical classification.

On the other hand, when the head of the bone has passed below instead of above the tendon of the obturator internus, a new relation of parts is developed, and new principles of treatment must be invoked, by reason of certain mechanical obstacles which have to be overcome in reduction. These are the luxations which were formerly described as “ischiatric dislocations,” and which were believed to be mostly irreducible.

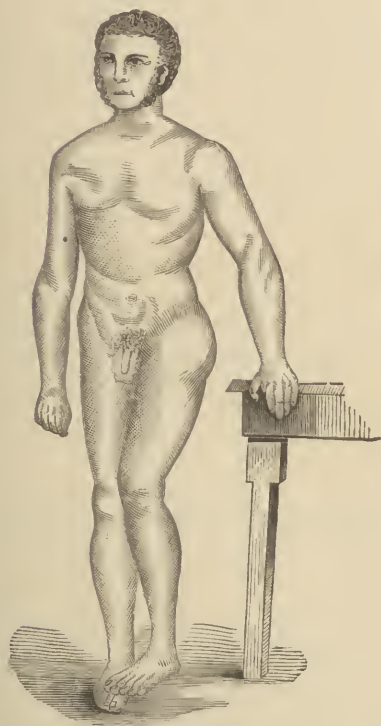
Causes.—It is not certainly known from clinical experience what particular form of injury produces the dislocation below, rather than that above the tendon of the obturator. Writers assume that the causes are the same as those which cause the other backward forms of luxation, except that the thigh is more flexed at the time of the injury, and that the direction of the force is more downward, so that the capsule gives way at a point below, instead of above, the tendon of the obturator.

Symptoms.—Bigelow says that there is extreme inversion in this luxation, and also an unusual amount of adduction, so that the affected thigh lies across its fellow as high as the middle third. The limb, however, may not be shortened, and may even hang lower than the other, when the patient is in the upright position.

Pathology.—As already mentioned, the head of the femur, in this form of luxation, slips below the obturator internus tendon. As soon as the thigh is

brought down from the bent or flexed position in which the displacement took place, the head of the bone, taking an opposite position by reason of the fulcrum action of the Y ligament, rises upward behind the tendon, which will now wind tightly around the neck of the femur between the head and its socket. It will be seen at once what an insuperable obstacle is here presented to every effort at reduction, unless some special manipulation can enable

Fig. 573.



Dorsal dislocation below the tendon of
the obturator internus.

Fig. 574.



Dislocation on dorsum ilii below tendon of obturator internus.
(Bigelow.)

the head of the bone to evade the tightly-drawn tendon, and reach its socket without resistance. More exact knowledge of the pathology of this particular form of luxation has taught us how to accomplish this, but it is not surprising that until recent years it should have been considered by the best surgeons as practically irreducible.

Treatment.—Traction after Cooper's method should never be employed in this dislocation. When the head and neck of the femur are made to advance toward the acetabulum by simple traction, they are at once arrested by the firm band of the tendon lying between them and their destination. No amount of simple traction can ever suffice to overcome this obstacle, and yet with only slight force, the bone being skilfully guided, all resistance may be avoided, and reduction may be readily secured.

Nor are the principles upon which this is to be accomplished difficult to understand and remember, if an accurate picture of the exact condition of parts be once fixed in the mind. Let the surgeon remember, then, that the tendon lies normally across the back of the joint, a little below its level; that, the thigh being sharply flexed, the head of the bone has burst its enveloping capsule and slipped below the tendon; and that it has gone up behind this

powerful band, which now lies tightly strung across the upper part of the femoral neck.

In attempting the reduction of such a luxation, the surgeon should proceed as follows: With the patient upon his back, the knee is carried across the opposite thigh to a position of extreme adduction, and from thence swept upward, horizontally toward the abdomen, until it is believed that the head of the bone has traversed downward below the tendon. Then the thigh is raised to a vertical position, and the head of the bone will be unlocked from the obturator tendon, and will lie simply in the position of a backward dislocation. Any of the methods already described for the reduction of backward dislocations, will now replace the bone in its socket without unusual difficulty. Thus the *traction* method of manipulation may be tried (see page 320), or the force of the hands may be assisted by a bar passed beneath the bend of the knee, or the patient may be laid face downward with his thighs hanging over the edge of a table, while the surgeon uses his hand or foot to make traction downward. The *rotation* method of manipulation may also be invoked, exactly as in a case of dislocation above the tendon.

Failure will sometimes occur in spite of the best directed efforts, when the head of the femur has gone below the tendon, to disengage it by any manipulation yet discovered. After a thorough trial of the methods which have been described, the imperative necessity of obtaining reduction will justify the employment of no less severe a procedure than the rupturing of the obturator tendon, in order to restore the bones to their normal position. The method of effecting this will next be detailed.

Manipulation to Rupture the Tendon of the Obturator Internus.—Recourse may be had to this extreme measure when other means have failed. The severity of the injury inflicted is not great, and by means of it, cases formerly considered hopeless may readily be reduced. On account of the serious nature of the deformity caused by a permanent dislocation, there would seem to be abundant reason for undertaking even a much more severe operation, could success be attained by it. All authorities agree in sanctioning the measure as a last resort. The manipulation consists mainly in circumduction of the limb while in the extended position. Let the femur be adducted and held at the same time flat upon the table or bed, with the thigh kept back at extreme extension. Now let it be swept strongly outward against whatever resistance it may encounter, until the tendon is believed to be torn across. In this movement, the neck of the femur is forced backward and upward directly in opposition to the tense muscle and tendon, and must tear their fibres asunder before it can be pushed far.

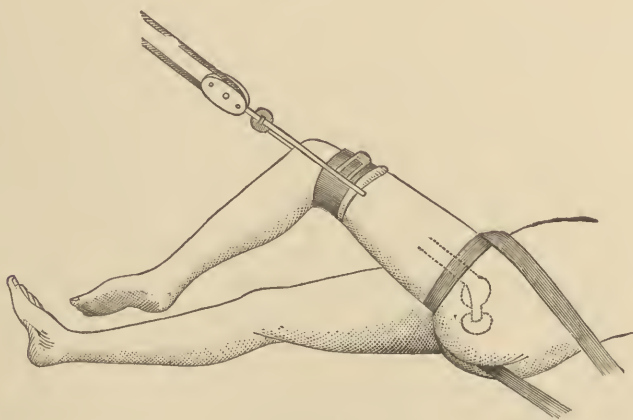
Older Methods of reducing Backward Dislocations of the Hip.—The obsolete methods of reducing luxations of the thigh-bone, recommended by Sir Astley Cooper and others, were briefly as follows:—

The patient was first freely bled, to induce a tendency to syncope and relaxation. Nausea was also produced by antimony, and relaxation further favored by placing the patient in hot baths. Although too much importance was then attached to muscular rigidity, and too little to ligamentous resistance, there can be no doubt that the treatment pursued tended greatly to assist reduction, and might even now sometimes be called for, were we not in possession of a far more efficient means of obtaining relaxation, in the induction of anæsthesia.

The patient was next placed upon the operating table, and secured by a strong perineal band passed between the thighs, and carried upward and outward to some staple, ringbolt, or other firm object, for counter-extension

against the extraordinary power about to be called into use for extension. To apply this extension, a damp towel was wrapped about the thigh, just above the knee, and sometimes over this a leather band was buckled, about which in turn was placed the terminal clove hitch of the extension rope. Traction was now made by compound pulleys, in the slightly adducted and flexed position in which the limb is always found. While the traction was thus being made, the surgeon gave to the thigh a rotatory movement both inward and outward, the leg being used, so to speak, as a crank, by grasping it near the ankle while the knee was flexed. After some moments, the tissues usually yielded under the enormous tension of the pulleys. The tension of the untorn side of the capsule no doubt dragged the pelvis into a somewhat

Fig. 575.



Cooper's method of reduction in dorsal dislocation.

more favorable position, some of the resisting fibres yielded or stretched, and the head of the femur gradually approached the socket, until finally it rode over the rim of the joint and snapped suddenly into place. The success attending the employment of the extending bands and pulleys, and the fact that for many years they were in general use, show that they were not as severe in actual practice as might be supposed *a priori*. Upon the old hypothesis, that chiefly muscular resistance needed to be overcome, there was nothing absurd in the use of great traction force. As to the question of ultimate results, few if any recorded cases can be produced to show that recovery was in any way delayed by the force applied. As to the employment, therefore, of Sir Astley Cooper's method, by a modern surgeon, any one will find good surgical authority for the use of the plan, should he choose to try it, and no harm is likely to result to the patient from the experiment; but my own belief is that it never need be employed by any one who has mastered the theory of manipulation.

Some uncertainty attended the use of pulleys, their application in the extended position making the ∇ ligament very tense, and causing it to exert such an enormous resistance as often to baffle the most skilful surgeons. Sometimes, by the use of a tripod to which the extension was attached in a position vertically above the patient's hips, much better results were obtained.

Jarvis's adjuster added still another facility, for while it was capable of furnishing an enormous amount of traction, it also permitted easy rotation, flexion, and adduction. Even when not best directed, these manipulations commonly assisted much in reduction, partly because they tended to break

resisting bands, and partly because they would often, by mere accident, bring the joint into a more favorable position than that of extension.

This adjuster is a most admirable instrument for producing extension, not only in luxations of the hip, but in all dislocations, especially ancient ones. Making its counter-extension from a point near the axis of motion of the joint, it allows of freest movements in all directions, and will, by this combination of manipulation and strong extension, produce results which the pulleys can never accomplish. Unfortunately, this admirable instrument is no longer manufactured, the modern methods of manipulation having done away with so many of its indications.

FORWARD DISLOCATIONS.—Forward dislocations include under one group all the varieties of displacement in which the head of the femur is thrown into a position anterior to a longitudinal line drawn through the acetabulum. The general distinctions by which these are rendered a separate group from the whole class of backward luxations, arise from the anatomical fact that the trochanter major cannot participate in the forward movement of the head, just as it cannot go back with any of the backward luxations, and for the same reason, viz., the opposition of the Υ ligament. The position of the limb is therefore in many respects the direct opposite of that seen in the backward group in general, eversion instead of inversion being a constant symptom; and the movements for effecting reduction are a more or less exact reversal of those which have been already described.

The group of forward dislocations includes the *pubic* luxations, or those directly forward, and the *thyroid*, or those upon the thyroid or obturator foramen.

General Causes, Symptoms, and Treatment.—Forward luxations usually occur in accidents where the force is applied to the thigh in full extension, as in falls upon the feet or knee, with the limb straight or bent a little back. Rarely, blows upon the hip have been known to cause this, as they have other forms of luxation. Extreme backward bending of the hip-joint without external violence has been known to produce a pubic dislocation, as in the case of Ure,¹ where the accident occurred in the act of striking out in swimming. Here also the limb must have been widely abducted at the same moment, though the abducted position more commonly causes the thyroid dislocation than the pubic. Sudden separation of the knees, as when a crushing weight falls upon the body, or as when in mounting a horse, or stepping upon a moving object, one foot is carried away from the other, may cause this injury.

The head of the femur is driven through the front of the capsule, inside of the Υ ligament, whose traction, assisted by that of the obturator internus, now rolls the shaft of the bone outward, and binds the trochanter against the rim of the acetabulum. The limb will therefore be externally rotated. It is usually abducted, and in the pubic variety commonly shortened; in thyroid dislocations it is lengthened.

The treatment of forward dislocations requires a more or less complete reversal of the manipulations used in the backward forms. It varies somewhat according to the different locations of the femoral head.

III. DISLOCATION UPON THE PUBIS.—*Causes.*—Extreme extension, or a little backward bending of the thigh at the moment of receiving a sudden blow, or falling upon the feet or knees, has been the cause assigned in most of the few recorded cases of pubic dislocation. It may also be produced by a very

¹ Lancet, Nov. 1857.

violent blow upon the back of the thigh, near its upper end. So slight a cause as a misstep has been known to cause this injury, but is much more likely to cause fracture of the neck of the femur, which often results from a slight fall.

Pathology.—The pathology of the pubic variety of dislocation has already been referred to in the general description of forward luxations. The position of the head of the femur varies from a point directly upward, under the Y ligament, to one directly forward upon the body of the pubic bone. Between these two points it may occupy a variety of situations. Sometimes it passes diagonally inward and upward under Poupart's ligament, disturbing more or less the vessels and nerves, but commonly pushing them aside rather than wounding them, and finding a location over and within the pelvic rim under the external oblique and transversalis muscles.

Symptoms.—The head of the femur can often be seen to form a large tumor upon the pubis, or wherever it may lie. Most frequently it rides upon the rim of the bone so as to be markedly prominent. The foot lies turned outward, and resists all attempts to give an inward rotation. As in the backward forms of hip-dislocation, there is a marked but not great amount of flexion, which will not yield to pressure, the only effect of pushing the knee downward being to cause an upward arching of the lumbar spine and a tilting of the pelvis forward. Instead of being laid across the opposite limb, the line of the thigh diverges on account of the abduction of the affected member, this being a slightly-marked but constant symptom. Upon the whole, the characteristic features of dislocation rigidly maintain themselves against any efforts at movement, and are resumed when the limb is left free. Upon measurement, the limb is, in most cases, found to be shortened one or two inches, the exceptions being in those cases in which the displacement is directly forward upon the pubis. Measurement also shows that the trochanter major is from half an inch to two and a half inches nearer to the symphysis pubis upon the affected than upon the other side.

A differential *diagnosis* between fracture of the femoral neck and pubic dislocation can always be made, when it is remembered that the outward turning of the fractured thigh is not accompanied by immobility, under an anæsthetic, nor by a flexed and abducted position which will not yield to the hand. The length of the limb can be restored by making traction, in a fracture of the neck, but not in a dislocation. The prominent tumor formed by the head in its new location will settle absolutely the differential diagnosis.

Treatment of Pubic Dislocations.—Bigelow recommends the following plans:—

(1) In the forward luxations, as in those backward, the new method involves the necessity of flexion, for the purpose of relaxing the Y ligament; but it is to be remembered that abduction, and not adduction, is the most favorable position for replacement. Proceed by flexing and abducting the thigh—carrying the knee up, and then out, in other words—and make traction in the direction of the axis of the thigh bone, having an assistant, at

Fig. 576.



Pubic dislocation.

the same moment, press the head of the bone downward and outward toward the acetabulum.

A modification of this method, sometimes successful, is as follows: Flex the thigh to a right angle with the body, and rotate the shaft of the bone strongly, either inward or outward, so as to wind up, as it were, the *Y* ligament upon the femur. With the hand of the surgeon, or of an assistant, pressing strongly upon the head of the bone, swing the limb downward to its place.

(2) The surgeon seats himself at the patient's feet, places one foot in the perineum, making counter-extension against the pubis and ischium, and rotates the limb inward by turning the foot. With his hand, or with a towel around his shoulders, he makes strong traction, and while this is kept up, assistants are ordered to lift the patient's body to a sitting posture.

(3) The patient is laid face downward, his limbs hanging over the padded edge of a table as heretofore described in connection with the treatment of backward luxations, and the knee or foot of the surgeon is placed in the popliteal space to make extension, while the flexed leg of the patient serves as a crank, by which inward rotation is effected. The knee of the affected side is held somewhat away from the other, for the sake of abduction.

(4) The patient is laid upon his back, and the surgeon, stooping over him or kneeling between his abducted thighs, places the dislocated limb so as to flex the knee over his shoulder, embracing the thigh near the pelvis. A large amount of traction can thus be obtained, and the hands can press the head towards the acetabulum.

(5) Circumduction (as in backward dislocations) may be necessary to enlarge the small "button-hole" opening in the capsule, before the head of the femur can be induced to enter its socket.

When, after faithful trial, this seems indicated, sweep the flexed thigh inward, against the fibrous resistance it will encounter, as if intending to convert the pubic into a dorsal dislocation; make strong enough traction, after the circumduction, to raise the patient's hips from the floor, so as to make use of the weight of the trunk for extension. Increased power may be added by making counter-extension with the foot in the perineum, or on the pubis. Sometimes assistance can be rendered by drawing the thigh outward, by means of a band passed around the inner side of the limb.

(6) The method of *rotation*, formerly called Reid's method, varies from that described as fitted for the treatment of backward dislocations, by a reversal of the movements. The limb is first flexed and abducted, then swept around upon the abdomen with the knee bent upon the thigh, the latter being held inverted. The direction of the sweep is toward the median line, or opposite to that employed in the backward form, as already described. When the knee has reached a point immediately above the acetabulum, it is brought directly down to full extension, the thigh being held everted as it comes.

Occasionally this manipulation will convert a pubic into a dorsal dislocation, in which case the latter will have to be reduced by the usual methods.

IV. THYROID DISLOCATIONS.—The thyroid dislocation, the last of the four principal varieties, is that form of forward displacement in which the head of the bone takes a downward as well as an anterior direction from its socket.

Causes.—Authorities assign as a cause of this injury, violence received while the limb is widely abducted. Although it is often asserted that a blow upon the back, as by a falling object while the thighs are spread, is the usual cause, probably this dislocation occurs most often in falling from a height

and striking obliquely upon the foot or knee, so as to abduct the limb forcibly.

Pathology.—The lower, front wall of the capsule gives way, its fibres being rather thin at this point, and the head of the femur slips forward along the horizontal ramus of the pubis to the region of the thyroid foramen, lying sometimes just upon it, sometimes above, and sometimes a little below and behind this opening.

Fig. 577



Mechanism of dislocation into thyroid foramen, showing the Y-ligament suspending the trochanter. The head of the bone lodged in the thyroid foramen, and the trochanter resting on the acetabulum. (Bigelow.)

Fig. 578.



Thyroid dislocation.

The positions of the head and the trochanter major, in most cases of this variety of luxation, are nearly in the normal plane, so that the neck of the femur points toward the median line, and there is little rotation. When the displacement is more nearly forward, the bone rolls outward to some extent, and when most nearly downward there may even be slight inversion, as in backward dislocation.

Symptoms.—Abduction is a constant symptom, and is more marked than in the pubic form of forward dislocation. The foot, as will be inferred from what has been said of the pathological anatomy, does not exhibit a constant tendency to either outward or inward version. Usually it points directly forward, rarely a little inward or outward. In whatever position it lies, it is found to be rigid. As in all the dislocations of the hip, there is some flexion, which cannot be overcome except, seemingly, by tilting the pelvis. This

flexion amounts to about thirty-five degrees. The limb is lengthened by from half an inch to two and one-half inches.

Treatment.—The methods of reduction already described for the pubic form of forward dislocation, are equally applicable to thyroid dislocations, with the addition of the following:—

- (1) The rotation instead of commencing with abduction (Fig. 579), and sweeping around, as described above for the *rotation* plan in pubic dislocations, may be made in the opposite direction, and with the limb adducted, precisely as in dorsal luxations. Some surgeons prefer this method, and claim for it equal success with the abduction and sweeping toward the body which is most usually advised.

Fig. 579.



Reduction of thyroid dislocation by manipulation.
(Bigelow.)

- (2) Reduction has often been effected by placing the patient in a sitting posture with his knees straight, and a hassock, roll of blankets, or other broad fulcrum between the upper part of the abducted thighs. The surgeon grasps the two ankles or knees, and presses them toward each other, thus prying the head into its socket by the leverage of the extended thighs.

In principle, many of the methods which have been described for anterior dislocations will be seen to be identical; they have been described independently, for the sake

of rendering the instruction more precise and intelligible in each instance.

Ancient Methods.—Although mostly obsolete, Cooper's methods call for description, because they were so recently in common use in forward as well as in backward dislocations of the hip. Briefly, they are as follows:—

- (1) In *pubic dislocations*, counter-extension was obtained by means of a sheet passed between the thighs, brought together on the outer side of the pelvis on the injured side, and its ends made fast to some firm support. By means of a clove hitch over a towel wrapped around the thigh, just above the knee, traction was made with the pulleys, or Spanish windlass, in a direction downward, that is, with the limb in extension, and a little backward, allowing the limb, for this purpose, to hang somewhat over the edge of the bed or table.

- (2) In *thyroid dislocations*, and other forward and downward forms of displacement, reduction was effected by laying the patient horizontally, and passing the counter-extending band about his hips a little below the crest of the ilium, carrying it across the body, back and front, and attaching it to some firm support on the sound side. This band did not pass between the thighs, but surrounded the hip. Next, a band for making extension was passed around the inner side of the dislocated thigh, near its upper extremity, and carried in the opposite direction, outward and a little upward. By means of pulleys this was tightly drawn, with a view of pulling the head of the bone upward and

outward to the acetabulum, while the surgeon grasping the ankle made extension, and used the leverage of the leg and thigh to assist reduction.

Various authors, as the result of experience or of reasoning, suggested modifications of the methods of Sir Astley Cooper, some of which added greatly to the facility of reduction, and were, in fact, steps toward the manipulation methods. These have been alluded to in detail in the historical account of the subject. It has not been the design of this article to describe minutely all the plans of treatment which have been, and might now be, more or less useful in the absence of modern, perfected methods, but rather to give these methods in their most improved forms, as practised at the present day, and the older and obsolete modes by way of contrast, omitting entirely the description of those intermediate varieties, which were, indeed, a vast improvement upon preceding plans, and which served as useful stepping-stones in the transition stage between the old and the new, but which, nevertheless, may now be said to have survived their usefulness.

IRREGULAR OR ANOMALOUS DISLOCATIONS OF THE FEMUR.—In rare instances the **Y** ligament becomes wholly or partly torn, in dislocations of the hip-joint, so that it does not exert its usual traction upon the neck and trochanter, and the limb does not assume the characteristic attitude as to rotation, flexion, or adduction, by which the diagnosis is ordinarily made.

I. SUPRA-SPINOUS DISLOCATION (Bigelow) is a form in which the outer branch of the **Y** ligament is broken, and the head of the bone is lodged above the anterior inferior spinous process of the ilium, with the neck lying across the rim of the pelvis, and the trochanter turned backward so as to rotate the shaft externally. Of course the eversion and shortening are very great. There is also some abduction, and the limb as usual is rigidly fixed, partly by the inner, untorn branch of the ligament, and partly because the head of the bone is hooked over the rim of the pelvis.

Treatment should be directed toward unhooking the femoral neck from the untorn part of the ligament, by sweeping the knee inward into the adducted position, at the same time rotating the femur outward until the head of the bone comes down upon the dorsum of the ilium, when reduction may be affected as in other dorsal dislocations.

II. EVERTED DORSAL DISLOCATIONS are said by various authors to have occurred. Ordinarily, the backward forms of luxation are accompanied by great inward rotation, or inversion, on account of the tension of the untorn **Y** ligament holding the trochanter forward as the head of the bone goes back. In the rare cases here referred to, the trochanter goes backwards with the femoral head, and lies behind it. Such a displacement could only occur where there had been free laceration of the external branch of the ligament, releasing the trochanter from its restraint.

The *treatment* is not materially different from that of the usual dorsal form, except that it must always begin by flexing, adducting, and inverting the thigh, before other manipulations are made.

III. OTHER RARE FORMS occur in which the **Y** ligament is completely sundered, together with other portions of the capsule. The retaining bands, which usually give distinctive positions to the displaced bone in the various dislocations, are wholly broken away in these cases, and no definite characteristics can be assigned them. Luxations of this kind are very rarely seen. Their *treatment* should be mostly by traction in whatever direction the limb most easily assumes, and with whatever manipulation each case calls for.

There will be much variation in these respects, according to the varying mechanism of the several injuries.

DISLOCATIONS OF THE HIP COMPLICATED BY FRACTURE.—Fractures of the shaft of the femur, accompanying any form of dislocation, greatly embarrass the process of reduction, as they deprive us of the leverage of the shaft in manipulation. Traction, however, may be employed efficaciously, and in several directions, unless the fracture be in close proximity to the joint. With the pubic dislocation, direct pressure upon the bone assists much in reduction. A probability of success attends patient trials even in these difficult cases. Should, however, all efforts fail, the alternative is presented either of leaving the luxation unreduced until union has occurred, and then treating the case as one of ancient dislocation, or of making a subcutaneous section of the outer side of the Υ ligament with the tenotome, in accordance with the practice recommended in dislocations of the elbow and other joints, rather than leave the bone unreduced. Under antiseptics, the operation is no more dangerous than the same amount of injury to the soft parts by simple tearing. I have frequently divided in this manner the resisting bands of old dislocations of other joints, and have thus accomplished reduction which was impossible by ordinary means, without causing the slightest unfavorable reaction, and without ever seeing bad results follow. For dividing the Υ ligament at its most resisting part, the tenotome should be entered over the prominence of the trochanter, carrying it deeply inward and giving it a curved sweep from before backward, so as to graze the upper margin of the bone.

Instead of section of the ligament, an incision may be made below the trochanter, down to the bone on its outer side, and the shaft may then be seized with lion-jawed forceps, while assistants hold the limb vertically and make strong extension, and so manipulated as to effect reduction; after which, proper extension for the fracture, and proper dressings for the wound, may be applied as usual. In spite of their severity, these measures, in my opinion, are warranted by the extremity of the case.

VOLUNTARY DISLOCATIONS OF THE HIP.—Of late years, several persons with abnormally lax joints have excited the interest of physicians and medical students, by their extraordinary power of changing the shape of their joints, so as to make them appear the seat of dislocation. These are cases of congenital peculiarity, in which several members of the same family are similarly constituted. One man in Chicago has so cultivated his power of displacing the bones, that he can at will produce nearly perfect dislocations of most of the synovial joints. His joints have always been very movable, and by cultivating the action of certain muscles he has attained the power of slipping the articulating surfaces of such joints as the hip and knee, in any direction at will. This laxity of his joint-capsules does not in any way interfere with his bodily strength or power of limb. He is, on the contrary, a man of great physical strength, and of unusual skill in gymnastic feats requiring steadiness and precision.

ANCIENT DISLOCATIONS OF THE HIP.—It was the opinion of Sir Astley Cooper that the shoulder-joint became so fixed in three months after dislocation, and the hip-joint in eight weeks, that it was in most cases imprudent to make any powerful attempt at reduction after those periods. I believe, however, that reduction can nearly always be accomplished even after a longer time. Much caution and patience, and a certain degree of boldness, where experience has shown that we may proceed safely, are requisite in the handling of these cases. On the one hand, greater force and greater persist-

once are requisite than in recent dislocations, and, on the other, it must be remembered that there is danger, from the adhesion of the head of the bone in its new location, of rupturing important vessels or other organs in using great force.

My own practice, in most difficult cases of ancient dislocation, is to make a subcutaneous, antiseptic division of the more or less resisting ligamentous tissues, using the instruments and plan of operation commonly employed in tenotomy. Of course, the tenotome should never be employed until after a thorough trial of the more common methods.

This mode of operative interference has not been indisputably proved to be the best for obtaining reduction in dislocations of any of the larger joints, since the literature of surgery does not furnish actual statistics sufficient for the purpose. I believe it to be justifiable, however, in the case of almost every joint in the body, as a common-sense deduction from what is known of the pathology of dislocations. Should there be any difference, it would be in the case of the larger joints, such as the hip, knee, and ankle, where the lighting up of suppurative synovitis might lead to fatal results. Without antiseptics, such an operation upon any of the larger joints should not for a moment be thought of.

DISLOCATIONS OF THE PATELLA.

OUTWARD DISLOCATION OF THE PATELLA.—*Causes.*—This luxation is occasioned either by external force, or by muscular action exerted in peculiar conditions. The patella may also be displaced laterally, as a sequence of caries of the condyles of the femur, when the disease destroys the ridge which retains the patella on one or the other side.

Symptoms.—If the dislocation be complete, the patella will be found lying on the outer slope of the condyle, with its inner border forwards; but if incomplete, the form of the articular surfaces is such that the patella will be tilted somewhat edgewise, with its outer border projecting forward. The knee is slightly bent, and immovable, and the patella may be felt in its new position. The pain is generally pretty severe. After reduction, the dislocation is liable to be reproduced from slight causes.

Treatment.—In order to effect reduction, it is best first to relax the quadriceps extensor by flexing the thigh on the body, and extending the leg on the thigh. When this is done, the bone can usually be replaced by lateral pressure of the thumbs. If reduction prove difficult, it will be necessary to anæsthetize the patient, and then to dislodge the patella by vigorous flexion and extension of the knee, and afterwards proceed again as before.

INWARD DISLOCATION OF THE PATELLA.—*Causes.*—This accident generally results from external force applied directly to the outer margin of the patella.

Symptoms and Treatment.—These are the same as in the outward dislocation, except that the direction of the displacement, and that of the pressure required for reduction, are reversed.

DISLOCATION OF THE PATELLA ON ITS AXIS.—In a few rare cases, the patella is completely overturned, presenting its posterior surface forward. In other instances it stops half-way, one margin being sunk in the outer condyloid fossa, while the other stands sharply forward, presenting a prominence beneath the skin which cannot be mistaken. In a case of complete overturning, the sharp margin of the articular surface, presenting outward, can be felt and

readily distinguished from the more rounded surface of the patella in its proper position.

Treatment.—In case of partial dislocation of the patella upon its axis, so that the bone stands upon one edge, the patient, after being anæsthetized to relax the quadriceps, should be placed with the leg in full extension, and efforts made to effect reduction with the hands. In case of failure, the knee should be forcibly bent and suddenly straightened, in order to loosen the bone from its impaction between the condyles, and then efforts should be repeated to bring it into proper position. If the head of a key, or some smooth object, be pressed in against the lower edge, while the hand pushes forcibly in the opposite direction against the projecting upper border, considerable advantage sometimes will be gained. In case of complete dislocation, reduction may be accomplished upon the same principles. Ascertain the direction of the torsion by examining the two edges of the patella, with the knee fully extended and the thigh somewhat raised, so as to relax the quadriceps. Then, by grasping and pushing one or other, or both, sides of the bone, as before, it may commonly be replaced without much trouble.

Should these manipulations prove unsuccessful, the surgeon would be justified in seizing the bone in the jaws of a pair of sharp-toothed forceps (like lion-jawed forceps, but more slender-toothed), and by the aid of these turning over the patella. Careful antiseptic precautions must be observed in this operation, since there is great liability for the points of one or more of the teeth of the forceps to enter the cavity of the capsule. Some authors recommend that the ligamentum patellæ should be divided, and also the insertion of the extensor tendon, in order to facilitate the reduction in difficult cases. The operation has not met with much favor on account of the risk of suppurative synovitis to which it subjects the patient. One case is recorded in which this occurred and proved fatal. Dr. J. B. Roberts, in his notes to Bryant's Surgery, advocates the operation.

DISLOCATIONS OF THE KNEE-JOINT.

Considering the great exposure of the knee to blows and other forms of violence, its dislocations are quite rare; in the vast majority of cases, the thigh or the leg will be fractured before the knee will yield. This immunity is not due to any peculiarity of the bony conformation, as in the case of the vertebræ, where fracture must nearly always take place before the bones can be disjoined, but to the uncommon size of the articulation and to its powerful ligaments. The existence of the crucial ligaments in the interior of the joint, and the great thickening of the capsule which at each side forms the lateral ligament, are the most important factors in resisting displacement. In describing dislocations, we speak of the lower bone as the one luxated. The tibia may then be dislocated upon the femur, either *backward*, *forward*, *inward*, or *outward*.

BACKWARD DISLOCATION OF THE TIBIA.—*Causes.*—Direct violence in the region of the knee is the usual cause of this injury.

Symptoms.—The head of the tibia is found, upon examination, to be driven back toward the popliteal space, where it may be felt by the hand. In front, there is a corresponding vacuity, and a depression immediately below the patella, on either side of the ligamentum patellæ. The amount of shortening is not uniform. Usually, the leg is extremely extended, and the line of the tibia slopes forward, forming an obtuse angle with that of the femur. The ligaments are more or less torn, according to the extent of the displacement,

and this has much to do with the prognosis. Ankylosis sometimes occurs here, as in other joints, when synovitis sets in after reduction. Usually, however, after replacement, a good recovery of all the original functions may be predicted. When the luxation is not reduced, there remains great imperfection of the limb, but in many cases more mobility and strength for walking exist than would naturally be anticipated.

Treatment.—In a certain number of cases, where the dislocation is not quite complete, it may often be reduced by manipulation alone without resorting to extension. For this purpose the patient may be laid upon his back, with a cushion under the calf of the leg, but not extending above the knee, thus leaving a vacant space beneath the lower portion of the thigh. Direct efforts are now to be made by the hands of assistants to press the femur backward, while the joint is rocked backward and forward, and occasionally laterally, to facilitate replacement. Failing in this, Hamilton recommends that the limb should be forcibly flexed, and then extended still further, in order to free it from resisting fibres, and that then reduction by pressure on the femur should again be tried. Alternate flexion and extension may in this way be tried several times, when, if reduction be not accomplished, extension and counter-extension by means of pulleys or other apparatus, or simply by the hands of two assistants, may be invoked to assist the reduction, the surgeon continuing the manipulations already described.

Fig. 580.



Backward dislocation of the tibia.

DISLOCATION OF THE HEAD OF THE TIBIA FORWARD.—In this injury, the tibia is found to be projected forward upon the condyles of the femur, which are correspondingly projected backward, bulging into the popliteal space. The important vessels and nerves of this region are frequently so pressed upon as to cause numbness and absence of pulsation below; and occasionally rupture of the popliteal artery may give rise to extravasation or traumatic aneurism.

Treatment.—Reduction may be accomplished in essentially the same manner as in backward dislocation, except that the forced flexion there recommended should not be employed. If pressure alone will effect replacement, and extension seem called for, as is often the case, the latter may be applied by the hands of assistants, or by pulleys, with perineal bands for counter-extension, the surgeon, by preference, keeping his own hands free to conduct the necessary manipulations.

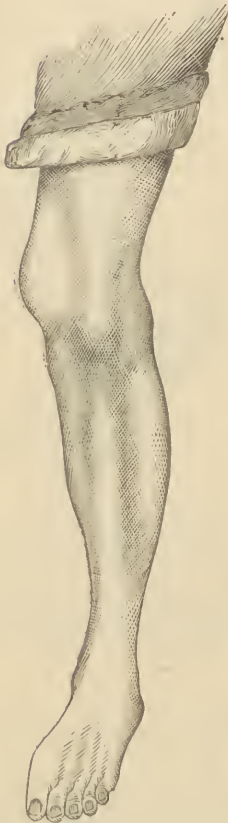
LATERAL DISLOCATIONS OF THE HEAD OF THE TIBIA.—The lateral dislocations are usually incomplete. In displacement of the head of the tibia *outward*, there is considerable lateral movement, but not complete separation of the joint surfaces. The articular facet which normally supports the inner condyle of the femur is carried outward, and rests under the external condyle, while the external facet of the tibia is carried out still further. As regards pathology and symptoms, the *inward* luxation is similar to the outward, except for a reversal of the direction of displacement.

The external appearance of the knee shows the prominence of the femur and the tibia upon opposite sides. There is no shortening of the limb, but

considerable immobility. No difficulty is experienced in determining the nature of the injury upon inspection and palpation.

Complete lateral dislocations at the knee are of very rare occurrence.

Fig. 581.



Incomplete, outward dislocation of tibia.

When from extraordinary violence they do occur, the extreme tension frequently causes the head of the bone to rend its way through the skin, causing a compound dislocation.

Treatment.—Incomplete lateral dislocations may be reduced by laying the patient upon his side, placing a firm cushion or pad beneath the projecting bone, and pressing the other bone down to its proper position. This pad may be put under either the upper or the lower bone. If any difficulty be experienced in this method, extension may be employed in addition to compression, and the replacement facilitated by giving to the two bones a rocking motion upon each other.

Oblique dislocations of the knee are said to occur, in which the head of the tibia takes a direction backward as well as outward. These cases are rarely met with. They are to be treated upon the principles already laid down.

COMPOUND DISLOCATION OF THE KNEE-JOINT.—This is an accident of not very rare occurrence, and of very grave importance. It has been the opinion of surgeons hitherto, owing to the very great fatality caused by the violent suppurative inflammation which is almost sure to follow conservative treatment, that primary amputation, or excision, is the obvious indication. In the case of a laboring man, or of any person unable to give up his employment a long time, and to obtain careful attention during a tedious confinement of months' duration, amputation has seemed to offer the best, safest, and quickest prospect of recovery, and, for practical purposes, a limb nearly as useful as any that could be obtained otherwise.

Persons who could obtain careful attention in good surroundings, who preferred the natural, though mutilated, limb to any artificial appliance, and who were also willing for the sake of this to undergo a somewhat greater risk of life, could have the knee-joint exsected, and recover ultimately with a motionless knee, but with the natural leg in place. The one other course—conservatism without excision—was under old methods so uniformly the cause of death from pyæmia and exhaustion, that it found no favor with surgical writers.

This opinion has not as yet been controverted, nor can it successfully be overturned on the basis of our present experience, for want of new statistics; but it nevertheless may be true that the introduction of the antiseptic method offers a means of saving the joint, and even of restoring its function, in some cases, with far less serious risk to life than any previous plan of treatment. We cannot, from the meagre statistics which we now possess, make a thoroughly scientific induction as to the prospects of this method of treatment without operation; but enough is known to render it perfectly justifiable for the surgeon to make an attempt to save the limb.

In carrying out such a plan, the utmost thoroughness is obligatory, and the openings for drainage must be made, and other details attended to, in accordance with a well-considered plan of local treatment, which involves considerable care and watchfulness.

Full instructions will be found on another page for making the six openings into the knee-joint, commonly used by the author, so as to obtain thorough access for drainage-tubes and for injections, to every square inch of its synovial lining. As the area of the joint surfaces in the knee far exceeds that of any other articulation, so does the severity of the reaction, when it is inflamed, while the necessity for efficient management in the local treatment is correspondingly increased.

In addition to the carbolyzed injections and antiseptic dressings, frequently renewed ice-bags of large size are to be applied to meet the first invasion of inflammatory symptoms, and to maintain a thorough, antiphlogistic influence. In this manner there will be hope of carrying the patient through a tedious convalescence, without great risk to life. Anchylosis very commonly but not invariably results. When this is considered inevitable, the limb should be placed in a slightly bent position, as this is found to be more favorable for locomotion and general comfort than that of full extension.

MINOR DISPLACEMENTS OF THE KNEE.—The peculiar structure of this joint, having a rim of fibro-cartilage forming a wedge-shaped layer around its circumference, leads to several minor accidents whose precise nature is often obscure. Injuries of this kind receive from different surgeons various names. Hamilton avoids the question of exact pathology, by classing all under the group of "*Internal derangements of the knee-joint.*" Erichsen denominates them "*Subluxations of the knee.*" Sir Astley Cooper regarded them as partial dislocations of the femur from the semilunar cartilages, and Malgaigne believed them to be subluxations of the latter cartilages from the tibia.

In all probability, a variety of different injuries occur within the knee, but as they lack the confirmation of post-mortem study, and as their external symptoms are slight, it is probable that the exact pathology of these injuries will remain in doubt. "Floating" or "loose" cartilages in the knee-joint are discussed in another article. Sudden strains in a rotary direction are said to be the cause of most of these internal displacements.

The symptoms are a sudden locking and violent pain in the region of the joint, often while walking. The patient is compelled to cease instantly all efforts at flexion or extension, and sometimes is thrown to the ground by his sudden inability to make the necessary movements to preserve his balance.

The treatment of these injuries consists in gentle manipulation. The reduction usually takes place after a little handling, without the patient or surgeon being able to say just what change in the relation of parts has occurred. If gentle movements, and pressure at different points, do not result in restoring to the joint a normal state of feeling and mobility, the patient may be anesthetized, and the limb strongly flexed and extended alternately, when its natural condition will soon be restored.

It is said that portions of the semilunar cartilages are sometimes broken loose, and driven into the interior of the joint. If such an injury should occur, its nature might be discovered by the touch of the finger, and reduction might perhaps be effected by rocking movements of the joint in various directions, so as to make the condyles of the femur act as wedges, and force the loose piece out to its place.

DISLOCATION OF THE HEAD OF THE FIBULA.—This is a rare accident which Bryant attributes in most instances to violent adduction of the foot and abduction of the knee.

The *diagnosis* is made by an examination of the relative positions of the heads of the fibulæ upon the two limbs. On the dislocated side, the bone is carried outward, and sometimes forward or backward from its usual situation, and is very readily felt and seen to be out of place.

Reduction is accomplished by making firm pressure of the thumbs upon the tumor caused by the displaced head. After reduction, a compress should be placed directly outside of the joint, and should be worn for several weeks in order to prevent redisplacement.

DISLOCATIONS OF THE ANKLE-JOINT.

Some confusion in the terminology of ankle dislocations has resulted because certain authors, such as Cooper, Malgaigne, and Hamilton, have described them as displacements of the lower end of the tibia, while others, such as Boyer, Ashhurst, and Bryant, have classed them as luxations of the foot from the tibia, preferring to regard the distal as that which is displaced upon the proximal bone, in accordance with the method of classification pursued in other parts of the body. Analogy would, therefore, lead us to regard the astragalus and not the tibia as the dislocated bone, although, in the strictest sense, all dislocations are, of course, a mutual separation of parts. Some considerations, however, have caused a number of modern surgeons to take the opposite view. Thus, in walking, the foot becomes a fixed base of support, and a dislocation, if it takes place, may be considered as a displacement of the moving tibia, especially since the articulating surface of the latter is so much smaller than the tarsus. The mind more readily conceives of the smaller organ being displaced upon the larger, than of the larger being carried away from the smaller. This question of nomenclature has no bearing upon pathology or treatment, but it is important to use such language as may explain itself at each step, and leave no ambiguity.

I prefer to regard the distal part as that which undergoes displacement.

Dislocations, then, of the tarsus upon the leg may be in four directions, viz., *forward, backward, inward, and outward*. Each of these dislocations is accompanied, in most cases, by a fracture of the fibula, a short distance above the joint.

LATERAL DISLOCATIONS OF THE TARSUS.—The dislocations inward and outward are usually incomplete, and, in fact, are to be considered rather as rotations within the joint, than as displacements of the astragalus from the tibia.

Causes.—This injury is frequently produced by falling so as to strike upon the foot, with the ankle turned over. The weight of the body, suddenly arrested, gives the joint a violent wrench, turning the foot over into the position of *varus* or *valgus*, so that its inner or outer border rests upon the ground. The fibula is broken as already mentioned.

Symptoms.—Usually, fracture of the fibula accompanies the lateral as well as the other luxations. Sometimes also the internal malleolus is broken. The inner or outer surface of the astragalus lies upon the articular extremity of the tibia, in most cases, but sometimes there is a true lateral displacement, in which case there is not so much rotation or turning of the foot. Complete lateral displacements are generally compound, a form of injury attended with great fatality.

Treatment.—In the slighter forms of lateral dislocation, the patient, or some bystander, not infrequently reduces the dislocation upon first observing it, simply by drawing the foot around into its true position with the hand. When

found still turned over, the foot may be reduced by making extension, or by carrying it around toward the axis of the limb, after which the fracture of the malleolus, which commonly but not invariably has occurred, is to be properly adjusted, and dressed with splints or plaster. The broken end of the fibula is sometimes very thoroughly separated from its shaft, and I have seen it completely overset, and presenting its ragged, broken edge outward and downward, even when the foot was replaced. Care should be taken that this loose fragment be set nicely into its old position. An anæsthetic is usually necessary.

In the more complete forms of displacement, very powerful traction may be required. Jarvis's adjuster, or pulleys, may be employed for this purpose. The patient being laid upon his back, the thigh is flexed upon the trunk and the knee sharply bent, to obtain muscular relaxation. Counter-extension is best secured by means of a band around the thigh, just above the knee, passing thence to some firm support, should pulleys have to be resorted to. A loop of cloth around the ankle furnishes attachment to the extending bands. The bent position relaxes the gastrocnemius muscle, and deprives the tendo Achillis of much of its power of resistance. As the extension is gradually applied by assistants, the surgeon employs his hands in making pressure upon the tibia and foot in such directions as tend to bring the bones together.

Rest in bed will usually be required in the after-treatment of these cases, even where no fracture of the malleolus is present. Bavarian plaster-dressings are of excellent service in cases where a fracture complicates the luxation.

BACKWARD DISLOCATION OF THE TARSUS.—Backward luxation of the foot upon the leg, sometimes called "*Dislocation of the lower end of the tibia and fibula forward upon the foot*," is of particular interest on account of the difficulties in the way of its reduction, the embarrassments encountered in maintaining the bones in position, and the malpractice suits which have resulted from the maimed condition in which the foot is often left.

Causes.—The producing cause must be found in some extreme violence exerted in the direction of the shaft of the tibia, when the foot is fixed upon the ground; hence falls, in which the patient strikes upon the feet, are the most common causes of this injury.

Pathology.—The great tendency to redisplacement met with in this dislocation, was not satisfactorily understood until Professor Jarjavay, of the Hôpital Beaujon, of Paris, demonstrated by a large number of dissections the existence of a fracture of the posterior rim of the articulation. The posterior ligaments, instead of being ruptured, were still intact in nearly all of these cases, and strongly united to the posterior lip of the joint cavity. The latter still retained its normal position in relation to the foot, having been separated from the rest of the bone by a fracture running obliquely upward and backward.

By reference to the annexed cut (Fig. 582), it may be readily seen that the removal of this posterior lip reduces the tibia at its lower end to a single inclined plane, which renders it extremely easy for the foot to slip backward, or, as some prefer to say, for the tibia to slip forward upon the foot.

Upon the smoothly rounded astragalus, the position of this broken joint surface, when reduced, is one of extremely unstable equilibrium, so that muscular contraction inevitably causes recurrence of displacement when extension is relaxed. It is said that Malgaigne made such strenuous attempts to retain the foot in place that, in one or more instances, he sacrificed the life of the patient by over-zealous efforts. His results, however, were no more commendable than those of other surgeons less energetic in their methods. The fibula is usually fractured in these, as in the lateral dislocations.

Symptoms.—External inspection shows the foot to have gone back, and a little up, from its true position. If the patient be laid horizontally, with the

Fig. 582.



Backward dislocation of tarsus.

leg upon a plane surface, it will be seen that the tibia is more advanced than usual; it lies in front, over the instep, presenting a great prominence which can hardly be mistaken, unless concealed by great œdema of the tissues in front. The heel, in other words, projects much too far backward, and the foot in front is too short. To the hand, if not to the eye, the prominence of the lower end of the tibia is very perceptible, and the tendo Achillis is drawn backward into a greater curve than its fellow.

Treatment.—Reduction may be accomplished by placing the limb in a flexed position, and making traction upon the foot by the hands of assistants, or by the pulleys, while the surgeon pushes forward upon the heel and backward upon the front of the leg. Merely to reduce the luxation, is usually not difficult; to prevent redisplacement, is in nearly every case impossible. There will be some variation as to the tendency of the bone to escape, dependent on the greater or less approximation to a single inclined plane of the lower end of the tibia, by reason of the fracture of

the posterior lip of the joint. As the fractured portion is out of the reach of any external manipulation, it is not always easy to elicit crepitus, and the surgeon is often obliged to infer the condition from the presence or absence of a tendency to relaxation. Great care in the after-treatment is obligatory in these cases.

The limb should be dressed upon a double-inclined plane to relax the gastrocnemius, and the foot kept at a right angle to the leg, with suitable bandages, and with splints of wood, leather, or plaster of Paris, adapted to the shape of the limb in such a way as, by firm pressure, to retain the parts in position. The most efficient application is undoubtedly the plaster-dressing, but it is also one the use of which requires caution, on account of the danger of compressing and stopping the circulation in the limb. The plaster-roller is especially objectionable on this score, since it cannot be relaxed if swelling occurs, without destroying it entirely. The best plan is to use about four layers of Canton flannel or crash towelling, with plaster spread between, wrapping these about the limb from the bend of the knee to the toes, and leaving a line of separation along the front, so that the splint may, at any time, be “sprung” open and taken off without injuring it for further use. The cloth layers should first be cut to wrap properly about the limb, and, when the dressing is applied, an ordinary roller is used to keep it in place. Merely loosening or tightening this roller controls the tightness of the dressing. With this splint, the limb may be examined daily, and still held with all the security which plaster-dressings afford against displacement. The constant tendency to relaxation will have to be met as the ingenuity of the surgeon suggests, by means of various pads and supplementary bandages. At best, success will be indifferent. All hope of permanent retention rests upon the possibility of securing a union of the fractured, posterior rim with the shaft. As perfect coaptation is probably impossible, this seems rarely to occur, and very great permanent deformity is the rule. Still, every effort is to be made in the direction indicated, and greater success will doubtless attend the more extensive use of plaster-dressings than has heretofore been obtained.

FORWARD DISLOCATION OF THE TARSUS.—This is the *backward dislocation of the tibia on the foot*, of many authors. The *causes* of this rare injury are similar to those of the backward form just described.

Applying the same tests as in the latter case, the *symptoms* are of an opposite kind, that is, the line of the tibia is too far back, the foot projects too much in front, the heel seems not at all prominent, and the end of the tibia is felt, if not seen, back of its proper position. Not only is the fibula generally found to be broken, but in most of the recorded cases the internal malleolus, as well, has been described as fractured. The bony conformation of the ankle-joint is such that dislocation can rarely occur without a fracture of one or both malleoli, or of some part of the articulating surface of the tibia, whence the fact that the leg or thigh bones so much more frequently suffer than the ankle, in severe falls upon the feet.

Treatment.—Reduction is effected as in the backward displacement of the tarsus. After replacement, a tendency to relaxation is not mentioned in the records as being troublesome, doubtless because the rim of the joint is not broken away as in the posterior dislocation. Plaster dressings are a valuable means in this injury of securing immobility and good apposition of the small broken extremities of the tibia and fibula. The rarity of the accident makes generalization uncertain as to *prognosis*, but this apparently is favorable in regard to ultimate recovery of full use of the foot. Dressings are to be worn for about six weeks from the time of injury, when the fractures will generally have become united. Passive movements may be begun much earlier than this, to prevent too much stiffening of the joint from mere disuse.



Fig. 583.

Forward dislocation of the tarsus.

DISLOCATION OF THE INFERIOR EXTREMITY OF THE FIBULA.—Only one example of this injury, in its simple form, is well attested. This is Nélaton's case, which is said to have been produced by a carriage-wheel passing across the ankle, or just above it, so as to force the lower end of the fibula backward, until it rested in contact with the tendo Achillis. The external face of the astragalus was distinctly perceptible at the usual location of the external malleolus, but the foot was in natural position, very strangely, not being inverted. The case was first seen six weeks after the injury, at which time the patient could with careful steps walk for a considerable distance.

The dislocation was pronounced incurable on account of the length of time which had elapsed.

The literature of the profession therefore furnishes no account of *treatment* in these cases. It is rational to suppose that this dislocation might have been reduced by pressure upon the bone from behind, with perhaps subcutaneous section with a tenotome of some resisting bands.

COMPOUND DISLOCATION OF THE ANKLE-JOINT.—In cases of severe fall, it is not very rare for the lower end of the tibia or fibula to be driven through the integument, so as to lay open the ankle-joint to the external air. Com-

pound dislocations of the ankle are accidents of extreme gravity, as is well shown by the number of fatal cases which are on record.

In deciding upon the course of *treatment*, we are to be guided to a certain extent by the statistics of the various plans which have been adopted. It is the danger to life, rather than the question of usefulness, which must chiefly guide us in determining what method to pursue.

As to pure *conservation*, the majority of cases in which simple reduction has been practised, have resulted disastrously by suppuration and caries, leading to pyæmia. Hence the precept has become pretty firmly established that primary *amputation* or *excision* should be performed. The perfection of antiseptic surgery has raised anew the question as to whether by very thorough drainage, with several large openings and daily, carbolyzed injections, conservative treatment might not be more successful, but this question is as yet not settled. I am inclined to believe in the future success of this method, but it certainly cannot now be unhesitatingly recommended, from lack of experience. We could not usually expect from this conservative, antiseptic treatment much better results than from excision, since the joint would in most cases become ankylosed; hence, unless much safer, the method would have little to recommend it.

A choice of four methods of operation may be made in compound dislocations of the ankle-joint. These are:—

- (1) Syme's amputation,
- (2) Pirogoff's amputation,
- (3) Amputation at the lower third of the leg,
- (4) Excision.

The relative dangers of these operations may best be shown by introducing here the following table of cases from the author's work on the mortality of surgical operations, and from Dr. Culbertson's well-known monograph.¹

OPERATION.	CASES.	DIED.	MORTALITY PER CENT.
Syme's amputation	325	30	9
Pirogoff's amputation	130	24	18
Amputation at lower third of leg (traumatic) . .	148	48	32
Excision of ankle (exclusive of gunshot wounds)	152	19	12

Of these operations, it will be seen that Syme's amputation is the first, and excision the next, in order of safety. The latter preserves the foot in such a perfect condition that many prefer it, as I do myself, in spite of the apparent, slightly-increased danger.

In point both of danger and of injury to the limb, the amputation at the lower third of the leg is the most objectionable of all, and ought never to be resorted to, save where there is great destruction of the tissues below. In ordinary practice, the percentage of mortality will be found less than in the above statistics, which include a large number of cases from the hospitals of Vienna and Paris, where a fearful mortality accompanies all surgical operations.

DISLOCATIONS OF THE BONES OF THE FOOT.

DISLOCATION OF THE ASTRAGALUS.—As distinguished from dislocation of the whole tarsus, this is said to occur when the astragalus is driven both from its tarsal and from its tibial articulation. By Malgaigne, this was termed a double dislocation. The displacement may be forward, backward, inward,

¹ Transactions of the American Medical Association, 1876. Supplement.

or outward, as well as diagonally between these directions. Occasionally, the astragalus is said to have been revolved partially upon its own axis, without much lateral movement, and even to have been driven upward between the bones of the leg.

The *causes* are nearly the same as those which produce dislocations of the whole tarsus.

The injury is *diagnosed* by observing that the foot is twisted to one side or the other, or very strongly flexed or extended, and that the astragalus forms a projecting tumor under the skin, in one or other location, as above stated. The tibia sinks down upon the os calcis, shortening the limb and causing the malleoli to approach the sole of the foot. In backward displacement, the tibia is forced somewhat forward, and the case resembles a backward dislocation of the tarsus. Sometimes from the stretching of the integument over the astragalus in its new position, the skin is ruptured, and the dislocation becomes compound, and from the great swelling and tension mortification may result.

Reduction is readily brought about, and recovery is prompt if the circulation is not impaired. Compound dislocations are to be treated as other compound dislocations at the ankle. To effect reduction, the patient, after being anesthetized, should have the knee flexed to a right angle, and the thigh held vertically, as already described, counter-extension being made at the lower third of the thigh, and extension upon the foot by the hands of an assistant, while the surgeon tries, by forcing with the palms of his hands, to push the bones into place. Failing in this manner, the extending force must be increased by mechanical aids, such as the Jarvis's adjuster, or pulleys. Where even this fails, the foot may be rocked to and fro during extension, to facilitate the surgeon's efforts to insinuate the bone into its proper position. Hamilton advises that oblique dislocations should, if possible, be reduced first to those of the anterior form, after which the bone is more easily replaced.

When the luxation has occurred laterally, the reduction is facilitated by turning the foot away from the dislocated bone, thus opening more widely the cavity for its reception. After reduction, the foot should be kept in strict repose, and signs of inflammation should be met with cold applications or warm fomentations, together with constitutional remedies for controlling the inflammatory tendency.

In case all efforts at reduction fail, amputation or resection may be considered, the choice of operation depending, in some degree, upon the amount of injury to the circulation and innervation of the foot.

DISLOCATIONS OF THE SCAPHOID AND OS CALCIS.—These bones are found displaced separately, or simultaneously. The study of the anatomical landmarks and comparison with the injured foot, show at once the nature of the injury.

Treatment.—Reduction is effected as in dislocation of the astragalus, by making extension with the knee flexed to a right angle, and pressing the bones toward their places.

The principles already laid down should govern the surgeon in the management of irreducible or compound dislocations of these bones. Amputation, or by preference exsection, may be resorted to. As to what results would follow conservative treatment, too few cases have been recorded to enable any estimate to be made of its mortality. I incline to the belief that antiseptic surgery may modify many old notions as to the treatment of foot-dislocations, in the direction of conservatism. In the absence of precedent, the surgeon is at liberty to apply general principles, and to follow his own judgment. Three courses therefore are open to choice, in irreducible dislocations of these bones: (1) To make a section of the ligaments with the tenotome, and then

effect reduction; (2) To leave the displaced bones still unreduced, trusting that, as elsewhere, more or less functional activity may be regained; (3) To remove the foot by Syme's or Pirogoff's amputation.

DISLOCATION OF THE SCAPHOID AND CUBOID FROM THE OS CALCIS AND ASTRAGALUS.—This is the *medio-tarsal* dislocation of Malgaigne and of Hamilton. It is a rare accident; but one which undoubtedly occurs in an uncomplicated form. Cooper and Liston have recorded instances. The foot is bent upon itself, as in congenital talipes. Simple extension is all that is required to bring the bones again into position, after which rest should be enjoined for several weeks, to secure union of the ruptured ligaments.

DISLOCATION OF THE CUBOID ALONE.—Some of the older surgeons assert the possibility of this injury, while others deny that any authentic cases are upon record. Extension, counter-extension, and direct pressure upon the bone, are the means which would probably be required to effect reduction.

DISLOCATION OF THE SCAPHOID ALONE.—A number of cases are well attested, in which this bone has been displaced, generally in an upward direction. The prominent tumor, formed by the displaced bone, makes the diagnosis easy when fracture is known not to exist. Reduction is of course effected by pressure upon the bone. By turning the foot away from the side to which displacement has occurred, reduction is assisted, as this widens somewhat the gap into which it is designed to thrust the bone in restoring it to its position.

DISLOCATIONS OF THE CUNEIFORM BONES.—These bones may be luxated either separately or together. The displacement will be recognized by examining the anatomical landmarks of the part carefully, and by studying the bony framework of the sound foot. The *treatment* is essentially the same as in luxations of the scaphoid, excepting as to the direction of the movements.

DISLOCATIONS OF THE METATARSAL BONES.—The whole of the metatarsus may be dislocated either forward or backward, and individual bones of the group are at times seen to be displaced in various directions. The luxations of all the bones constitute injuries which are easily recognized, and in which reduction is readily accomplished.

In these cases the foot is shortened, and either a prominence or a vacuity exists upon its dorsal aspect, according as the heads of the bones have gone forward or backward. Considerable pain and swelling occur in a short time after the injury, and may to some extent obscure the symptoms, and prevent the determination of the existence or non-existence of fracture.

The *treatment* consists in making extension upon the toes and pressing the heads of the metatarsals toward their places. This is not easy in cases where only one of the bones has been displaced. Where any difficulty occurs, an anæsthetic is needed—in many cases as much to help in diagnosis as in treatment, since it is all-important not to overlook the presence of a fracture, should any exist.

DISLOCATIONS OF THE PHALANGES.—These displacements are rare. Blows received upon the ends or sides of the toes, or violent wrenchings of the toes, however produced, are the general *causes*. The direction of displacement may be forward or backward, usually the latter.

The *diagnosis* cannot be difficult, except in cases of fracture, or where the swelling is great. The *symptoms* are too obvious to need description. The

treatment is similar to that practised in dislocations of the fingers. Luxations of the small toes are readily reduced by extension and pressure on the heads of the bones. In the case of the great toe, there may arise difficulty similar to that seen in dislocations of the thumb, and reduction may be found wholly impossible, save by division of the lateral ligaments with the tenotome. Excision or amputation may be considered, if this is not thought advisable, and more particularly in cases of compound luxation, in which the ordinary principles governing joint injuries are applicable, as laid down in another section.

“BONE-SETTING” AND “NATURAL BONE-SETTERS.”

The title of *natural bone-setters* is claimed by a peculiar class of empirics, found both in America and abroad. In Spain they are termed *Algebristas*. In the United States, those who have claimed this power have been mostly members of one family, or have claimed to be such. They have mainly practised in the New-England States and in New York. Among the ignorant classes, a belief prevails that certain persons are born with a natural instinct, or knack, which enables them to diagnose and “set” obscure or difficult cases of dislocation which have proved too much for the skill of educated surgeons. Sir James Paget, in an address to his class, thus refers to the “bone-setters” met with in England:—

“Few of you are likely to practise without having a bone-setter for your enemy; and if he can cure a case which you have failed to cure, his fortune may be made and yours marred.”¹

It would be unnecessary to spend time in describing the performances of these itinerants, were it not for the grain of scientific truth that, only half understood by themselves, and often wholly ignored by the profession, lies concealed under the curious mixture of ignorance and wilful misrepresentation in which their practice largely consists.

The cases in which these persons succeed in making cures, are certain chronic forms of lameness, or other disability, following various acute diseases, or dislocations and sprains.

These are the cases in which they confidently pronounce the limb “out,” or “out of joint,” though every man who understands anatomy can see at a glance that the bones are perfectly in place. In many cases, they actually wrench loose certain ligamentous adhesions presently to be mentioned, and in others they gradually loosen up, by exercise, parts stiffened by disuse, and thus set patients on the road to recovery, who had in vain followed the cautious advice of educated surgeons. Those bone-setters who lack tact and judgment, not unfrequently do serious and dangerous mischief by their manipulations, in cases of traumatic synovitis, but others are cautious, and reject cases in which inflammation is present, as unsuited to their art. Only a small part of their business consists in setting real dislocations; but their “natural gift” consists largely in declaring every injured limb to be “out of joint,” no matter what the lesion really is, and in proceeding to what they pretend, or perhaps believe, to be a “setting.”

Dr. Wharton P. Hood, who personally took a course of instruction under one of these bone-setters, gives a typical description to illustrate the cases benefited by his bone-setting preceptor, as follows:—

¹ Wharton P. Hood, *On Bone-Setting, etc.*, p. 3. London, 1871.

A healthy man sustains a fracture of the forearm. Splints are applied in the usual way, and occasionally re-applied. After a number of weeks the bones are united, and the man is discharged, cured. He is still unable to use either his hand or his forearm, but is assured that his difficulty arises only from the stiffness incidental to their long rest, and that it will soon disappear. Instead of disappearing, it rather increases, and in due time he seeks the aid of a bone-setter. The arm and forearm are then bent nearly at right angles to each other; the forearm is intermediate between pronation and supination; the hand in a line with it; and the fingers are straight and rigid. Passive motion can be accomplished within narrow limits, but produces sharp pain, localized in some single spot about each joint, in which spot there will be tenderness on pressure. The bone-setter will tell the man that his wrist and his elbow are "out." The man may object that the injury had been in the middle of the forearm. The reply is that perhaps the forearm had indeed been broken as alleged, but that the wrist and the elbow had been "put out" at the same time, and that these injuries had been overlooked by the doctors. The bone-setter would then, by a rapid manipulation hereafter to be described, at once overcome the stiffness of the fingers, and enable the patient to move them to and fro. The instant benefit would dispel all scruples about submitting the wrist and the elbow to manipulation, and these also would be set free in their turn. The man would go away, easily flexing and extending his lately rigid joints, and fully convinced that he had sustained grievous harm at the hands of his legitimate doctors.

The traditional pathology of the natural bone-setters is that everything is "out"—that is, dislocated—and that their manipulations "set it." Sometimes a trick is resorted to, to give the patient the sensation of something "slipping into joint." For instance, the following case fell under my own notice:—

A patient sprained the articulations of the centre of his tarsus, but, after careful examination by a thoroughly trained surgeon, no displacement of the parts was found. The inflammation and swelling were slowly subsiding, when the foot was submitted to a "natural bone-setter." He at once found a bone "out," as usual; and placing a thumb with firm pressure on the extensor longus pollicis tendon, on the dorsum of the foot, he dexterously manipulated, so that the tendon slipped suddenly sideways from under the end of his thumb, with a sharp, painful sensation. The patient probably believes to this day that he felt the bone "slip into place," and attributes his continued recovery to the "setting."

As far as "natural bone-setting" consists of mere tricks and lies, we may dismiss it with other forms of quackery, but that part of the business which consists in restoring joints to usefulness, which educated physicians have been unable to cure, is well worth the attention of scientific men.

The art and science of "natural bone-setting," as practised by the best specimens of the craft, may be summed up in about four propositions:—

- (1) All troublesome joints are "out."
- (2) If there is no active inflammation, they are to be "set" by the manipulations presently to be described.
- (3) Inflammatory cases are to be rejected, or else treated until soothing measures have subdued the inflammation, and then "set."
- (4) All subsequent improvement is to be ascribed to the "setting."

The real state of facts is as follows:—

(1) Joints which for various reasons have been kept immovable for several weeks or months, become more or less fixed in position from the contraction of muscles and ligaments, which, having never for a long time been put on the stretch, adjust their nutrition to their shortened form.

(2) When injuries have occurred in the vicinity, certain parts may become adherent, such as tendons to their sheaths, or planes of ligamentous fibres to other planes, above or beneath them, on which they ought to slide freely.

(3) Nerve twigs running between movable parts may become adherent from plastic effusion, so as to be dragged upon every time movements take place.

(4) In a few cases, slight partial adhesions of synovial surfaces occur, which, being ruptured, liberate the joint from its bonds.

A vigorous twist, with full flexion and extension, stretches contracting parts, and often ruptures abnormal adhesions, thus curing the patient; and it makes no difference whether this is done by the manipulations of a bone-setter, or by an accidental fall or wrench.

For instance, a gentleman in Chicago, who had his knee badly stiffened, as the sequel of an accident, was limping along in unusual haste one day, when he fell and doubled his knee forcibly under him. The result was an immediate and complete cure of his lameness.

In case of mere contraction of muscles and ligaments, the cure can usually be obtained by gradual increase of movement; but if nerve-twigs are adherent, or if the patient is hysterical or very nervous, the pain attending each effort frightens the sufferer, and the plan of gradual extension cannot be carried out. These are cases for the bright triumphs of the bone-setter, who gets hold simultaneously of the imagination and of the limb, and heroically ruptures the adhesions.

Cases of synovitis are injured by such treatment, and the more ignorant of the bone-setters often do irreparable mischief by wrenching joints which are thus affected, but those who have more tact learn from experience, or from the traditions of their elders, to recognize and avoid cases attended by inflammation. Some, however, use poultices, etc., and, after the inflammation has subsided, proceed to their manipulations.

The bone-setter seeks, or pretends to seek, for some spot about each stiffened joint, which is painful when motion is attempted, and which is also tender upon pressure. This is the point of adhesion to be ruptured. Dr. Hood lays much stress upon the importance of pressing the thumb firmly upon such spots while making the motions necessary to rupture the adhesions, but as far as I can judge of his reasons, the thumb-pressure seems to me unnecessary. However this may be, these points are the points of pain and of resistance on attempting motion, and consequently the points where rupture or stretching must be effected. Their position will assist the operator in deciding what direction to give to his forced movements. In general terms, therefore, the forced motions are to be those which are most painful, and which are opposed by the greatest resistance. The points of thumb-pressure are said to be, in the majority of cases, on the back or front of the carpus, if the wrist is affected; on the tendon of the biceps, at the bend of the elbow, if that joint is stiffened; on or near the point of the coracoid process, in the case of the shoulder; near the ligamentum patellæ, in that of the knee; and about the malleoli, in that of the ankle.

The manipulations of Hutton, an English bone-setter, were, according to his pupil Dr. Hood, as follows: If an interphalangeal articulation were stiffened, the bone-setter first got a firm grip upon the patient's proximal phalanx by passing the left index-finger transversely around or across its palmar surface, and pressing the thumb firmly on the dorsal aspect. He then seized the distal phalanx in the same way, with the right-hand, and forcibly flexed the joint as far as possible. Next he brought the distal phalanx to a semi-flexed position, and then by lateral rocking, that is, by abduction and adduction, he endeavored to stretch the lateral ligaments. The operation was finished by making complete extension. Motion was then found to be

much more free than before, and the patient was directed to keep up moderate, voluntary movements.

The management of the metacarpo-phalangeal articulations was precisely similar, except that, the parts being larger, more of the hands of the operator could be applied in the grasp. In these small joints no attention was paid to thumb-pressure.

At the wrist, the bone-setter took the lower end of the forearm transversely in front of him. Seizing the part above the wrist in such a way that his own thumb would be on the carpus of the patient, he sought the tender, resisting point, and pressed his thumb upon it, grasping the limb at the same time with the whole hand; with the other hand he seized the hand of the patient firmly, and then, after twisting the wrist-joint, suddenly brought it to a position of extreme flexion, and as suddenly straightened it again.

In the elbow, the operator, by various flexions, compressions, and rotations, ascertained the motion which was the most painful, and also the position of the tender spot. Then laying the back of his hand on the corner of a table, he received the patient's elbow in his upturned palm, and placed his thumb on the tender spot, which is generally near the insertion of the biceps muscle, and seized the patient's wrist in his right hand. If the previous examination had shown flexion and adduction to be most painful, the operator flexed the elbow, and at the same time pronated it and rotated the arm inward, so as to bring the forearm across the chest; but if flexion and abduction had been found the most painful, he supinated the hand, and rotated the arm outward while flexing. The motions were made suddenly.

There is an obscurity about these terms "adduction" and "abduction." One who attempts to adduct or abduct a flexed elbow, will accomplish nothing but a rotation of the humerus inward or outward, a movement which could have very little influence on adhesions and contractions about the elbow. Probably the whole efficacy of the manipulation lay in the flexion and extension, and in the rotation of the radius.

The shoulder was treated in the same way, first finding the tender spot for thumb-pressure, and the direction of painful motion. The operator then pressed the thumb to its place, generally over the coracoid process, and made a series of strong, rapid motions in such a direction as to rupture the limiting bands.

Hutton used to seek a motion strong enough to communicate a tearing sensation to his hand. I once tried this plan on a case which was precisely like those described by Hood. The tearing sensation occurred as described, but the real benefit of the operation was not superior, if equal, to that obtained by vigorous and well-directed, daily, passive exercises. It might be possible to rupture the axillary artery if there were old adhesions, by making the upward sweep.

In the ankle, the bone-setter took the heel in the palm of one hand, seized the anterior part of the foot in the other, and made two strong, sudden flexions of the ankle, one with an inward and the other with an outward twist. Of course, the magical but useless thumb-pressure was always put on.

In the knee, the plan was, according to the description, uselessly complicated. The patient was seated in a chair, and the operator stood in front of him, with the patient's foot between his knees and thighs. Then clasping the fingers behind the upper part of the calf, and putting on the thumb-pressure, he jerked the knee somewhat upward. Having thus started it, he next hooked an elbow under the knee, and, seizing the ankle, forcibly flexed the limb. If the knee was found bent, the opposite motion was performed. The educated surgeon will see at a glance that these movements, if forcibly made in an old case of fibrous ankylosis, might readily fracture the tibia, an acci-

alent, indeed, which has not unfrequently occurred in the hands of good surgeons.

The hip-joint was treated on similar principles, the flexion force being obtained by placing the patient's leg on the operator's shoulder, while the latter's hands grasped the thigh to rotate it, or steadied the pelvis by pressing down upon the groin. Dr. Hood says that if the limb be "elongated," the flexion should be made in an "abducted" direction. As the limb seldom or never is actually elongated in such cases, I presume that he means the apparent elongation produced by stiffening in a position of abduction.

The whole theory, as far as it contains valuable elements, may be summed up in the following principles:—

1. The points of adhesion in painful cases will be found at the spots which are tender when pressed upon, and when the part is put on the stretch.

2. The points of resistance in cases of painless stiffness are found by moving the part in different directions.

3. These points are to be ruptured by quick, strong motions, and the freedom thus gained must be preserved by daily exercise.

If any one will master these three propositions, and superadd a lying habit of declaring every stiff or painful limb to be "out of joint," he will then become a "*natural bone-setter*."

It is evident that many cases of lameness may be properly treated by this method, but it is also true that most of them can be better but more slowly cured by systematic exercise. The two classes of cases which require the rupturing plan are:—

1. Those in which there are adhesions so firm that nothing else will liberate them.

2. Those in which the patient cannot remain under the surgeon's care long enough for the employment of the gentler, gradual plan.

SPRAINS.

A sprain is a wrench of a joint, of such force as to overstrain and often slightly tear the fibres of the capsular ligament, without dislocating the bones. The ankle and the wrist are the most frequent seats of this injury, but the elbow and the knee are not uncommonly affected, while the shoulder and the hip, owing to the wide freedom of their motions, are seldom the subjects of sprains. In the ankle, sprains are almost invariably caused by an inadvertent step, in such a direction as to turn the sole of the foot inward, and lacerate the outer lateral ligament. In the wrist, sprains result from falls upon the hand. All the articulations of the hand or of the foot are occasionally sprained.

COMPLICATIONS OF SPRAINS.—Although the laceration or overstretching of the capsular ligament constitutes the essential element of a sprain, yet other tissues are often injured. Thus tendons may be ruptured and muscles torn. Still more frequently, the synovial membrane is contused or lacerated, giving rise to a severe synovitis, and small vessels are generally torn, causing extravasation of blood, either within or without the joint, or both. At the wrist, the ligaments are very powerful, and when sprained they often drag with them the articular extremity of the radius, causing a fracture of the lower end of that bone.

DIAGNOSIS.—In joints swollen from the effects of sprains, care is necessary to avoid errors of diagnosis. In an uncomplicated, recent sprain, however

great the swelling, all the bony landmarks will be found in correct, relative position, which fact will exclude the suspicion both of dislocation and of impacted fracture, while the distinction from non-impacted fracture rests upon the absence of crepitus and of abnormal bony mobility. Incomplete fractures may exist without detection, until revealed by the formation of provisional callus.

SYMPTOMS AND HISTORY.—Immediately after the occurrence of a sprain, there is severe pain, often accompanied with something like faintness and nausea. The swelling generally commences almost instantly, from the effusion of blood into the tissues, and continues afterwards from the advent of inflammation of the parts affected. If the synovial membrane has suffered, there is synovitis, and a consequent rapid filling up of the sac of the articulation with synovial fluid, often mixed with blood. In severe cases the patient is totally disabled, but in mild cases he often continues to use the joint moderately during convalescence. Acute suppuration rarely follows, unless the patient is of a very aplastic or suppurative diathesis; but the chronic synovitis which follows in some of the cases, frequently lays the foundation of caries and suppuration at a later period, if the synovitis be not properly treated. Where synovitis does not supervene, caries and suppuration cannot easily occur. If the patient be of a strongly rheumatic constitution, the local irritation often seems to derive a special obstinacy and persistence from the presence of the rheumatic diathesis.

The inflammatory symptoms in persons of healthy constitution, usually abate in a few days, and in a few weeks disappear; but there is a mechanical trouble which often remains longer, and is even aggravated by the very immobility enforced as a curative measure. The various bands and layers of ligament around a joint, have, normally, certain free, sliding movements upon each other, and transmit small nerves and vessels along their interspaces. When the ligamentous tissue is torn by the sprain, the same force rends the nerve-twigs, and the sensitive fibres thus injured are liable to become entangled in the cicatricial tissue formed during the healing, so that movements of the part are hampered and painful. These are the cases which, as already mentioned, furnish triumphant successes to the "natural bone-setters;" and it is easy to see that the longer the surgeon enforces stillness under these circumstances, the worse his patient's condition may become.

TREATMENT OF SPRAINS.—The most contradictory precepts have been given respecting the management of sprains, but the following plan accords with the general sense of the profession:—

(1) A severe sprain demands rest in the horizontal position for a few days.

(2) A steady and judicious use of cold will prevent the supervention of severe inflammation, and in a few days all tendency to its occurrence will have passed away, when the cold can be slowly withdrawn. Many favor hot instead of cold applications, and others decide between them according to the sense of comfort or discomfort felt by the patient. Warm-water applications, indeed, do well for some patients; but cold, properly regulated, will irresistibly quench the inflammation in all ordinary cases; and there are few or no patients who will long find it disagreeable, if it be regulated with proper tact and care. Whichever plan of treatment is adopted, should be steadily maintained.

(3) The liquid effusions poured out from the torn fibres into the tissues, during the first forty-eight hours, are irritating, like similar effusions after other mechanical injuries, and there is great advantage in getting rid of them. Unfortunately, the drainage tube cannot be employed here, but by gentle

kneading (*massage*), followed by the application of a bandage, the fluid can be pressed away to less irritated regions, whence it may be absorbed. This effect is rendered possible by the fact, that all the cavities of the connective tissue communicate with each other freely, like the meshes of a sponge. Professor Agnew would postpone massage longer, but experience proves that gentle stroking, with deft and equable hand-pressure, from below upwards, soothes the pain, diminishes the tenderness, and presses away the irritating secretions into other non-inflamed portions of the connective tissue. There is no harm but much benefit to be gained by this measure, if employed with skill and care once or twice a day.

(4) As soon as the acute inflammation, or the tendency to it, is somewhat abated, we must bear in mind the liability of the lacerated layers of ligamentous fibres to form abnormal adhesions among themselves, and to adjacent nerve fibres; hence we must, after a few days, follow the stroking massage, first with passive, and then with active movements of the joint, in all the directions of its normal motion.

In case the synovial membrane participates in the inflammation, the active and passive exercise must be greatly limited. The diagnosis can generally be assisted by pressing the joint surfaces firmly together, in such a way as not to strain any of the tender ligaments. If acute synovitis exists, this pressure will elicit pain, and, as all friction and pressure of inflamed synovial surfaces upon each other is injurious, the surgeon will then be compelled to modify his desire to move the hampered ligaments, and must comply measurably with the demands of the synovial membranes for rest. Fortunately, a very free movement, made once a day, will often suffice to free the ligaments from their adhesions, without seriously retarding the recovery from synovitis.

As time passes on, and it becomes clear that there is no synovial inflammation present, the surgeon should become bolder in his manipulations, and in chronic cases should persist in them, even though some ligamentous irritation should follow each effort. In cases which have become decidedly chronic in spite of gentle exercise, and in which there is neither a rheumatic diathesis nor synovitis present, it will be justifiable to resort to the wrenching plan of the "natural bone-setters," already described, and by strong, forced movements, to rupture the adherent fibres. For detailed instructions as to the methods of these manipulations, the reader is referred to what has been already said on the subject in a preceding part of this article. Finally, if all other measures fail, it may be best in some cases to practise neurotomy on certain nerve-twigs, so as to paralyze the sensation of the adherent spots, and thus rid the patient of his pain.

CONTUSIONS OF JOINTS.

These injuries differ from sprains more in their causes than in their effects. The nature of the lesions, and their subsequent course and treatment, are so closely allied, that what has been said of one class will apply to the other.

IRRITABLE JOINTS.

This is the term employed by Prof. Agnew¹ to denote certain cases of sudden inflammation of a joint, occurring weeks or months after the sprain or injury.

¹ Principles and Practice of Surgery, vol. ii. p. 133.

The term irritable joint seems to me not well chosen, because the symptoms described are those of inflammation. Prof. Agnew advises immobility and counter-irritation. If synovitis is present, extension as well as immobility is desirable; in short, the treatment is the same as in other joint inflammations.

WOUNDS OF JOINTS.

This very important class of injuries comprises several varieties, viz., incised wounds, punctured wounds, lacerated wounds, compound dislocations, and compound fractures including gunshot wounds. Strictly speaking, these varieties are not always distinct, for a gunshot wound of an articulation is always lacerated, and is generally also a compound fracture; nevertheless this division of the subject facilitates its discussion.

I. INCISED WOUNDS OF JOINTS.

These are the simplest of the penetrating traumatisms of joints. The *causes*, of course, are the entrance of any sharp instrument into the capsule of the articulation. The primary *symptoms* are not necessarily conspicuous. Generally there is a perceptible effusion of synovia, which, in doubtful cases, serves to establish the diagnosis, and, in some instances, by keeping up a slight outward flow, prevents for several days the entrance of septic bacteria into the cavity, and prolongs the time in which the surgeon has an opportunity to close or guard the orifice, and to prevent the occurrence of purulent synovitis.

The synovial secretion is recognizable by its transparency and viscosity, but the wound of a bursa near the joint may sometimes yield a similar fluid, and thus throw doubt on the diagnosis. In such a case, cautious probing is justifiable, if the probe be dipped in an antiseptic solution, and if the orifice of the wound be kept guarded by irrigation with the same. The intimation of some authors, however, that the surgeon may dismiss his anxiety and his precautions, in case he find only a bursa wounded, is absurd; for many of the bursæ around articulations have open communications with the synovial sacs of the joints, and may propagate through these orifices the most deadly suppurative inflammation.

TREATMENT.—Incised wounds of joints should be treated throughout with antiseptic precautions of the most thorough character. If carbolic acid is the article selected for the wash or spray, one part to forty is a good proportion. Carbolyzed oil, for use on lint, should be stronger, say one part to twelve. The examination, the cleansing from foreign substances, the suppression of hemorrhage, and the closure of the wound, should all be effected under antiseptic protection. I am no advocate for all the details of Listerism, and hold the spray especially to be often a very undesirable, as well as an inefficient, antiseptic guard; but in dressing wounded joints it is frequently very useful, though never indispensable. The principle to be acted upon is simply this: that there must be allowed no opportunity for septic particles, floating in the atmosphere, to remain in a living state, either on or in the wound. This is the end to be aimed at, and every well-educated surgeon must select his own means of attaining it.

If the joint have been widely opened, or contaminated by the admission of foreign substances into the sac, the interior must be antiseptically washed out. If the wound be small and recent, and no special reason exist for believ-

ing that the capsule has foreign substances within its cavity, it is best to assume that the blade which wounded it was wiped clean by the outer tissues as it entered, and that the outflow of blood and synovia has prevented septic particles from entering. As a matter of fact, in narrow wounds, the steady outflow of viscid synovia often protects the interior for several days from the entrance of septic influences. The wound, being promptly closed by ordinary methods, should have a thorough antiseptic covering, and should be maintained in a state of perfect immobility. If inflammation occur, cold applications should be vigorously employed, without in the least relaxing the antiseptic precautions. I advocate no servile adherence to the peculiar methods of Lister, or of any one man; nevertheless, in wounds of joints, a skilful use of antiseptic principles is of extreme importance. If the principles are well comprehended, every surgeon can devise his own methods of applying them.

In many cases, the synovial fluid will increase rapidly after the closure of the joint, causing considerable distension of the sac, and this fluid, produced under the inflammatory influence, seems to be of an irritating character. It should be promptly withdrawn, either by repeated aspiration, or by opening a corner of the original wound under antiseptic precautions; and in some cases it is best to insert temporarily a small drainage-tube, keeping it always under strict antiseptic guards.

If suppuration ensue despite all care, or if it have already occurred before the surgeon sees the case, the wound must be boldly laid open in such a way as to admit of perfect drainage, and of regular daily washing out of the interior with antiseptic fluids, of which carbolized water, of the strength of one part to forty, is one of the best.

INCISED WOUNDS OF THE KNEE-JOINT.—The knee-joint, owing to its size and complexity, has an enormous surface of synovial membrane, amounting to about one hundred square inches, and if we include the bursa under the quadriceps femoris, which very often either communicates with the synovial sac by a free opening, or else constitutes a wide, upward extension of the sac itself, the area will be little short of two hundred square inches.

The synovial membrane of the knee always forms two, and sometimes three cavities, sufficiently separated from each other to prevent one part from being washed out through another, and yet connected enough to allow septic infection to contaminate every corner of the whole.

The lower cavity is formed by that part of the synovial membrane which is below and behind the patella. This membrane covers the top of the tibia, lapping down about half an inch over its edges, and then, turning upward, covers both surfaces of the semilunar cartilages, and extends upward, about an inch, on each side of the condyles of the femur. From the condyles it is reflected downward and forward, covering the whole end of the bone. At the level of the patella, the synovial sac is constricted considerably, and partly shut off from the cavity above by the pressure of the patella and of certain ligamentous folds against the front of the femur. Above the patella the sac expands again into a large cavity, which often extends pretty high behind the quadriceps muscle. Above the synovial sac proper, is the great sub-muscular bursa which separates the quadriceps from the front of the femur, and which is often connected by a large opening with the sac of the joint itself.

The anatomical text-books give a partly erroneous impression, in saying that this bursa does not always exist. For surgical purposes, it is always present; if not as a perfect sac, yet as a very loose connective tissue, which offers no resistance to the diffusion of putrid pus. Even when well developed, the bursa is traversed by a mesh-work of fibrous bands, which grow more

numerous in the upper portion, until they merge into the loose, intermuscular, connective tissue of the thigh. There is usually no definite, upper boundary to the bursa, and an injection thrown into the knee-joint of a cadaver may often be made to run up through this loose tissue to Poupart's ligament. Hence the facility with which pus in the knee-joint will burrow its way upward, and cause vast abscesses in the thigh.

We have, therefore, in point of fact, three large cavities to consider:—

- (1) The sub-muscular bursa.
- (2) The supra-patellar cavity.
- (3) The infra-patellar cavity.

The bursa is sometimes separated completely from the joint, but it is not correct to say that it is ever totally absent from the limb, in such a sense as to exclude the risk of extensive purulent infiltration. When the knee is bent, the patella, with the ligaments on either side, is pressed with great firmness against the front of the femur, closing the narrow isthmus of the sac pretty completely, and effectually preventing the washing and draining of one segment of the synovial sac through the other, or of the bursa through either, while the septum between the joint and the bursa, though often incomplete, prohibits free cleansing of the synovial sac through incisions in the bursa, or of the bursa through the sac. When general suppuration of all the cavities exists, each one must have its own means of drainage. It is for want of appreciating these mechanical facts that surgeons have been so often baffled in attempting to disinfect suppurating knee-joints.

As the nervousness of many patients prevents the daily insertion of a syringe-pipe into openings with raw edges, the washing of the cavities in that way is often difficult. It is, therefore, better to anesthetize the patient, make all the openings at once, and place drainage-tubes in them, which, once in position, receive injections without pain. Each of the three cavities should have at least two openings, so placed that the purifying injection will enter at one side, and, sweeping across the cavity, pass out on the other, thus completely washing away all putrid pus. Dr. Markoe has shown the value of this principle of "through drainage" in various injuries and diseases, and it is unnecessary to discuss it here.¹

The best locations for the introduction of drainage-tubes are eight in number, but it is not generally necessary to use more than six on one patient, that is to say, two tubes for each cavity.

The eight points of incision are as follows:—

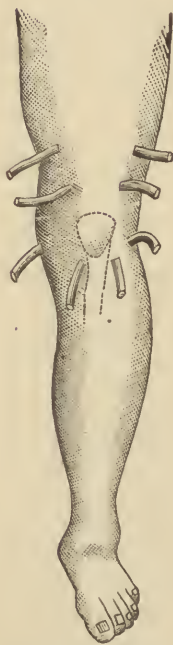
- a. One on either side of the bursa;
- b. One on either side of the supra-patellar, synovial expansion;
- c. One on either side of the condyles, where the synovial sac is reflected, about an inch above the semilunar cartilages, and near the posterior part of the joint;
- d. One on either side of the ligamentum patellæ.

These positions are shown in the annexed illustration.

In making use of these points, the following principles will guide us:—

1. If the bursa be not affected, the incisions and tubes for its cavity may be omitted.

Fig 584.



Shows the eight points available for drainage of a suppurating knee-joint.

¹ American Journal of the Medical Sciences, April, 1878.

2. In the early stages of a wounded knee-joint, the flexing of the knee and consequent closing of the patellar isthmus by the pressure there, sometimes prevents for a time the spread of the pus and of the inflammation from one cavity to the other. In such cases, by keeping the knee bent, and by thorough antiseptic drainage and injection of the single cavity which is found suppurating, I have been able to prevent the inflammation from spreading to the other cavities, and to obtain a cure with but little trouble.

3. Whatever cavities are affected, they should generally, as before said, be drained, each from two points, and sometimes from more. In the cavity below the patella, sufficient drainage can generally be procured by placing one tube in front, by the side of the ligamentum patellæ, and another on the opposite side of the joint, in front of the hamstring tendons, and just above the junction of the femur with the tibia. If the capsular ligament should prove so tense here as to render difficult the insinuation of a tube, the surgeon may facilitate the procedure by extending the incision backward, close under the hamstring tendon, where the capsule is voluminous and loose. By this plan the lower cavity can generally be well washed out, since the fluid passes diagonally through the joint. It should be borne in mind, however, that the back part of the cavity is divided into two lateral pouches by a synovial fold, which is reflected from the back of the joint, forward, to cover the crucial ligaments. Where this causes any difficulty in complete cleansing, it may be necessary to put a tube into each pouch, near the hamstrings, so that a stream thrown into the front opening may divide, and irrigate each pouch.

By effecting the cleansing of all three cavities in this thorough and systematic manner, the practical surgeon will find that suppurating knee-joints are freed from most of their dangers. As this is rarely done, a large portion of the patients thus affected die, not at all from the necessities of the case, but from blood-poisoning, due to the wretched insufficiency of the measures employed to free this complex cavity from its mass of putrefying pus.

Knowing how dangerous it is to open a healthy knee-joint, the practitioner often has a vague idea that there is equal or greater danger in freely opening one which is suppurating, not considering that he has for practical purposes no longer a synovial sac, but only an abscess, to deal with, and that the more widely it is opened, the less dangerous it is. Not comprehending this truth, he proceeds timidly, and with fear and trembling, to inject a little purifying fluid through a single opening into one of the cavities, but fails utterly to disinfect even that one, to say nothing of the other two. Of course he gains nothing, and the patient grows rapidly worse. Thus baffled, the average practitioner has not the courage to make additional openings, or, if he has, he knows not how many of them he should make, nor where he should locate them, and to the shame of surgical literature it must be added that he will find in his text-books no adequate instructions on these vital points.

The systematic treatment of incised wounds of the knee-joint should conform to the above principles, and may be briefly stated as follows:—

If seen in its recent condition, before suppuration has been set up, the wound should be opened and disturbed only as much as is strictly necessary for examination and cleansing from foreign bodies, and this preparatory exploration should be done with careful antiseptic precautions. The cleansing being completed, the wound should be closed and dressed antiseptically, and all subsequent dressings should be conducted with similar care. If the joint have been exposed to the air widely enough to become contaminated with dirt and foreign bodies, it must be not only freed from such objects, but washed out with some suitable antiseptic fluid, carbolized water of the

strength of two and a half parts to the hundred being as safe an article as can be found. If there be no proof that any foreign substances are in the joint, and if there have been no long exposure to the air, the wound may be closed at once without any injection, but should be dressed antiseptically, as before.

As the physician in private practice will not find at his patient's bedside a pair of steam-spray machines, with all the other complex appliances of "Listerism," it will be well to describe here an extemporaneous antiseptic plan, which can be carried out in any place where carbolic acid, or any other good antiseptic, can be obtained.

First let the surgeon prepare a quantity of carbolized water of the strength of about two and a half per cent., or one part of crystals, or of 95 per-cent. acid, to forty of water. This can be used to wash the wound, to syringe the joint,¹ and to apply as a wet dressing. As a substitute for the carbolic spray, let an assistant, during the dressing, keep a little of the two-and-a-half per cent. solution dripping constantly across the wounded surface, which will effectually prevent all septic infection from without. Sutures and adhesive plasters may be used if needed. A thick compress of cotton batting, lint, or soft towelling, soaked in the carbolized water, may now be laid on the closed wound, and the whole covered with strong paper dipped in melted lard, tallow, cerate, or wax. A wrap or bandage retains the whole in position. Such a dressing will remain perfectly aseptic for twenty-four hours. If longer intervals between the dressings are required, it is better to soak the cotton or lint compress in a mixture of one part of crystals of carbolic acid, in twelve parts of any bland oil, or of glycerine. Such a compress, covered with oiled paper, will retain its antiseptic powers perfectly for several days.

With materials thus extemporized, a practitioner who comprehends the principles of the art can make absolutely antiseptic dressings.

If inflammation has ensued in the synovial sac, and has as yet only invaded one segment of it, then a small opening should be maintained in one angle of the wound, under antiseptic guards, in order that the irritating fluids may escape freely, and not accumulate under a pressure which would lift the patella, and allow them to enter the other segment of the sac. To prevent this, it is well to temporarily flex the knee somewhat, and thus constrict the isthmus of the synovial cavity in the manner already explained. If, however, the disease has spread to the whole cavity, the flexed position should not be long maintained, lest it become permanent.

If suppuration invades the entire joint, it puts the patient in serious peril of his life, unless resolutely treated. The pus undergoes decomposition, and rapidly poisons the blood by absorption. It fills not only all the deep, complex pockets below the patella, but the wide sac above it, and often penetrates along the meshes of the great bursa above, and converts the whole front of the thigh into a long, diffused abscess, whose vascular walls absorb the putrefying fluids with deadly rapidity. In addition, caries is often induced in the articular surfaces, forming a very grave addition to the previous troubles.

I have been thus particular in describing the management of incised wounds of the knee, because of their great danger, and of the wretched inefficiency of the treatment ordinarily adopted. The limits of this article do not admit of equal details regarding all the other articulations, but the principles are the same, and with these, guided by his anatomical knowledge, the surgeon

¹ Two and a half per cent. is the proper strength for syringing out a suppurating joint cavity. To wash out a healthy, freshly exposed, synovial sac, not yet suppurating, one half this strength will be better.

need not hesitate about his duty. Macnamara¹ advises to drill through the bones into suppurating joint cavities, for the purpose of drainage, but his suggestion has not proved acceptable to other surgeons, since it is easier and simpler to make openings, wherever needed, in the capsule.

The drainage-openings of the hip may be made behind or in front of the trochanter, and those of the ankle on either side, below or in front of the malleoli. The tarsal articulations may be opened wherever they are most accessible. The joints of the phalanges should be drained from the dorsal aspect. The wrist-joint is to be reached on either border, a little towards the dorsal side. The elbow can be opened around the border of the olecranon, and at the junction of the head of the radius with the humerus. The shoulder can be drained in almost all directions, but especially anteriorly and externally.²

From the earnestness with which I have recommended drainage by incisions and tubes, no one should infer that it is proper to neglect a vigorous use of cold and other antiphlogistic measures in the early stages. Antiseptic drainage should be simply added to and not substituted in the place of, other treatment. All these rules, of course, will be often modified by the location of the original wound.

II. PUNCTURED WOUNDS OF JOINTS.

Punctured wounds of joints often recover with surprising ease. If made by a slender weapon, the opening closes instantaneously without admitting any air, and though some acute synovitis may follow, it is in most cases easily managed by cold applications, and not very apt to terminate in suppuration. Should it be otherwise, however, and pus be formed, the principles already inculcated must be applied. As the first step, the cavities of the joint may be emptied once or several times by the aspirator. If the pus grow more watery with each aspiration, and be free from offensive odor, and the inflammation abate, there will be hope of a complete cure by aspiration alone, or by aspiration conjoined with antiseptic washing of the cavities through the aspirator tube; but if the parts do not improve, then free incisions must be made, and antiseptic treatment in full be adopted, as in cases of incised wound.

PUNCTURES OF FINGER-JOINTS.—One of the most common joint-wounds of the punctured variety is made by biting. Men of the lower class, in fighting, have a strange proclivity to bite each other's fingers. A tooth penetrating a digital articulation sets up suppurative inflammation, and the putrid effusions, finding no ready escape on account of the closure of the puncture, burrow around the phalanges, strip off their periosteum, and lead to necrosis. These wounds should be tested at the outset with a fine probe, to discover any opening into the joint, and if one be found, it should be antiseptically treated at once. If it be seen after inflammation of the articulation is already fully set up, free incisions made immediately, and full antiseptic measures, will prevent very severe mischief.

¹ Diseases of the Bones and Joints, p. 115. London, 1881.

² Baden has published a valuable article on incisions for drainage of joints (Berlin klin. Wochenschr., Aug. 6, 1877). Packard, in his edition of Holmes's System of Surgery (vol. iii. p. 245), discusses the matter briefly. Articles bearing on the subject may be found in various periodicals, especially Edinburgh Medical Journal, September, 1875; Lancet, 1875; British Medical Journal, September, 1875; Gazette Médicale de Strasbourg, 1 Sept. 1877; Schmidt's Jahrbücher, Band 174, S. 268; Deutsche Zeitschrift für Chirurgie, Band x. S. 296; Deutsche med. Wochenschrift, 24 Nov. 1877; Centralblatt für Chirurgie, Dec. 8, 1877; Ibid. S. 480, 1878.

III. LACERATED WOUNDS OF JOINTS.

The principles of treatment in these severe injuries are similar to those already laid down for the management of incised wounds, but the hope of union without pus-formation is very slight, and the surgeon will generally have to combat the suppurative tendency from the outset. As far as these wounds belong to the class of compound dislocations, they have already been considered in a previous portion of this article.

The other causes of lacerated joint wounds are the violence of machinery, falls upon angular objects, and all the various accidents which may wrench the bones far enough from their proper relations to lacerate their surrounding soft parts. The elbow is especially subject to lacerated wounds when bent suddenly backward. Thus a lady was overturned in her carriage while the horses were running away. As the side of the vehicle neared the ground, she put her hand through the open window against the pavement. The carriage, still rushing forward, brought the window frame against the back of the elbow, bending the forearm violently backward. The bones were not fractured, but the anterior ligaments gave way, with most of the soft parts on the anterior aspect of the articulation, laying the joint widely open. Under thorough antiseptic treatment the parts healed with no other disaster than ankylosis.

Lacerated wounds will sometimes unite by first intention; hence in recent lacerations of joint capsules, and of their overlying tissues, the surgeon should consider whether he may not, by prompt antiseptic closure and adoption of the subsequent measures advised in speaking of incised wounds, preserve a useful articulation. If nothing prohibit the attempt it should be undertaken with the same care and minute attention to the perfection of antiseptic precautions, which have already been recommended in cases of incised wound. If the effort fail, and suppuration ensue, or if the purulent stage have already set in when the patient comes under the surgeon's care, then the treatment must be by drainage tubes and injections, or, if caries have set in, amputation or resection may be required.

IV. GUNSHOT WOUNDS OF JOINTS.

These injuries are generally both lacerated wounds and compound comminuted fractures, though in a few cases a bullet, cutting along the side of a joint, merely opens the capsule without shattering the bone. The army rifle-bullet is large, and when it passes directly through an articulation, it generally reduces a large part of the ends of the bones to a fine gravel, consisting of comminuted, osseous and cartilaginous material, besides splintering the remoter portions of the articular, osseous extremities. The large quantity of bony gravel left in the joint places it in a very different situation from that of an ordinary compound fracture, and stamps as idiotic all efforts to treat cases attended with such comminution in a merely conservative manner, whether with or without antiseptics. The first thing, therefore, in a case of penetrating, gunshot fracture of a joint, is to examine carefully, and determine whether the bone be comminuted or not. If the capsule be merely cut open, leaving the bone untouched, the treatment may be as in other cases of lacerated joint-wound. If the bone be broken, but not comminuted, the case may be treated as other compound fractures of joints, but if it be badly comminuted, the surgeon must generally choose between amputation and excision, or the

semi-conservative course of opening the articulation, and clearing out the fragments. If there are any situations in which a more strictly conservative plan would be admissible, they are in the hip-joint and in the spinal articulations, where it is obvious that certain complications may compel surgical inaction as to an injured joint, when otherwise an operation would be imperative. Common sense and not arbitrary rules must guide in such cases.

GUNSHOT WOUNDS OF VERTEBRAL ARTICULATIONS.—A long discussion of these injuries would not be appropriate here, because their chief importance consists in the mischief done to the cord, and not to the articulations as such.

The vertebræ, being composed of cancellous tissue, are very liable to absorb, through their opened and non-contracting venous channels, a vast quantity of putrid material; hence septicæmia is very liable to occur, as in the case of the late President Garfield. This disaster can be prevented in a few cases, where the wound happens to be so located as to admit of exploration with some degree of safety. It is therefore a sound doctrine to explore such wounds to the bone, if it can be done without much risk, and to try to establish drainage and an aseptic condition in the bone-wound itself; but if the exploration be likely to evacuate the spinal fluid, or do other fatal mischief, it is idle to pretend, as some have done, that such an examination should be persisted in, even at the risk of hastening death. It is to be remembered that a bullet is itself generally antiseptic, being covered with condensed sulphuric and sulphurous acids from the combustion of the powder in the gun, and that its passage through cancellous bone by no means insures septicæmia. In many cases, an exploration pushed far enough to reach the perforation in the vertebra, would be more dangerous than to trust that part of the wound to nature. There have been as yet no sufficient statistics accumulated as to vertebral wounds, to enable us to lay down precise rules of conduct, and until science does us this service—a very difficult, if not an impossible service in this class of cases—each surgeon must be guided by his best judgment on general principles. Those writers who allege that surgical science has a settled rule for every possible contingency, do not consider, or do not know, the actual state of surgical literature.

Dr. Otis¹ gives a table of 642 cases of wounds of vertebræ, with 55½ per cent. mortality. He gives also a table of sixty cases, in which various operations were performed upon the wounded vertebræ, with 27 deaths, which is a mortality of 45 per cent. The unavoidable, mathematical inference from these figures is, that the cases operated on were ten-and-a-half per cent. more successful than the average of the whole; but there is no practical value in this inference, because it is not known whether those selected for operation were cases of average severity.

The only conclusions, therefore, which are at present admissible, are these: In gunshot fractures of the spine, very careful examination should be the rule, and in many cases incisions should be made with judicious boldness, both to assist the exploration, and to enable the operator to remove fragments of bone, bullets, and pieces of clothing, and last, but not least, to enable him to thoroughly drain the fracture, and to keep it purified with antiseptics. In other respects the patient must be treated according to general principles, guided by the special study of each case.

GUNSHOT WOUNDS OF THE SHOULDER-JOINT.—These vary exceedingly in gravity, as do similar injuries elsewhere. The joint may be torn to frag-

¹ Med. and Surg. Hist. of the War of the Rebellion. Part First, Surgical Volume.

ments, or simply opened, or may suffer any intermediate degree of destructive action. In bullet wounds of the shoulder, the orifice in the thick deltoid muscle is apt to contract and resist the free exit of pus, and lead to a destructive burrowing of septic fluids. If the joint be opened, and the bone merely notched or grooved by the bullet, without being shattered, it will not usually be necessary to amputate or excise, but only to open the parts freely, and treat them antiseptically. If the bone be shattered, we have to consider more energetic measures, or, in other words, we must choose between amputation and resection. For a shoulder-joint badly shattered by a bullet, mere conservative treatment is too dangerous to be considered. The Medical and Surgical History of the War of the Rebellion, it is true, seems to show an advantage of several per cent. in favor of expectant treatment, but if we reflect that the cases selected for this plan were the least severely injured, the apparent statistical advantage is more than accounted for by the mildness of the cases. He would be a rash man who should be so infected with conservatism as to leave to unaided nature a shoulder-joint filled with bony gravel from the comminution of the humerus.

As between amputation and resection, the difference shown by several collections of statistics is only about two per cent. The most valuable tables on this subject are those collected by Dr. Otis, in the Medical and Surgical History of the War of the Rebellion, and by Dr. H. Culbertson, in his prize essay, published by the American Medical Association in 1876. The brevity of this article does not admit of a full statement of all the statistics bearing on this subject, but from a careful search of the literature of both continents, supplemented by the above-named documents, I have been able to condense the following results:—

MODE OF TREATMENT.	CASES.	DEATHS.	MORTALITY PER CENT.
Expectant treatment	577	144	25
Amputation at shoulder for traumatic causes (nearly all gunshot wounds)	1177	457	39
Resection of shoulder in similar cases	1408	518	37

It will be seen, therefore, that resection appears to be somewhat safer than amputation, besides preserving a very useful limb. As between primary, intermediary, and secondary operations, the intermediary are considerably the most fatal, but the primary and secondary do not greatly differ. The conclusions are obvious:—

(1) In gunshot wounds of the shoulder, with but slight injury to the bone, we should open the joint widely, and treat it antiseptically.

(2) In comminuted fractures, where the circulation and innervation are tolerably well preserved, we should resect the joint.

(3) Where the innervation and circulation are destroyed, or nearly so, we should amputate.

(4) Primary operations are to be preferred.

GUNSHOT WOUNDS OF THE ELBOW-JOINT.—The degree of comminution of bone in these injuries varies extremely, but even in the most favorable cases, the results of the wound are very serious. The complexity of the joint is such that it is difficult to drain it, or disinfect it, with any completeness; hence purely conservative treatment has not such success as one could desire, even when the bones are but slightly injured. Demme and Salzmann give the mortality of conservative treatment at sixty per cent., yet in General Sherman's campaigns, Drs. Andrews and Woodworth found only twenty-five per cent. of deaths, showing that in well-selected cases expectancy is admis-

sible.¹ Generally, however, the comminution is such that we have no choice except between amputation above the elbow and excision of the joint. In regard to the selection between these two operations, such contradictory opinions have been expressed by eminent authorities, that surgical literature on this point is eminently confusing. This state of affairs can only be accounted for by supposing that many authors of prominence have preferred to form opinions by guesswork, rather than by a laborious sifting of facts. It is necessary, therefore, to discuss the question with some care, in order to reach the solid truth. The following statistics have been gathered with much labor. From the mode of collection adopted by different authors, a part of the cases are undoubtedly included twice, but it is impossible to completely separate them, and as the reduplication includes recoveries and deaths alike, it probably does not materially alter the ratio of mortality:—

SHOT WOUNDS OF THE ELBOW TREATED WITHOUT OPERATION.

AUTHORITY.	CASES.	DEATHS.	MORTALITY PER CENT.
Otis, Med. and Surg. Hist. War of the Rebellion	924	96	10

SHOT WOUNDS OF THE ELBOW TREATED BY AMPUTATION OF THE ARM.

AUTHORITY.	CASES.	DEATHS.	MORTALITY PER CENT.
Otis, Med. and Surg. Hist. War of the Rebellion	1119	272	24

AMPUTATION OF ARM FOR GUNSHOT WOUNDS OF VARIOUS LOCATIONS.

AUTHORITIES.		CASES.	DEATHS.	MORTALITY PER CENT.
Med. and Surg. Hist. War of the Rebellion	Primary	3259	602	...
“ “ “ “ Intermed. and second.		1313	416	...
Andrews and Woodworth's Surgery of General Sherman's Campaigns	{ Primary	55	5	...
Chisolm, of Confederate Army	{ Secondary	4	1	...
“ “ “ “	Primary	294	42	...
“ “ “ “	Secondary	140	53	...
Warren, of Confederate Army	Primary	92	16	...
“ “ “ “	Secondary	100	38	...
Various Surgeons, Franco-German War	Primary	22	10	...
“ “ “ “	Secondary	16	9	...
Schmidt's Jahrbüch. Bd. 156. Crimean War	Primary	849	489	...
“ “ “ “	Secondary	146	86	...
“ “ “ Schleswig-Holstein	Primary	19	9	...
“ “ “ “	Secondary	12	8	...
“ “ “ Siege of Antwerp	Primary	9	1	...
“ “ “ “	Secondary	2	1	...
Guthrie's Commentaries. Brit. Army, 1815	Primary	21	4	...
“ “ “ “	Secondary	51	13	...
Totals . .		6404	1803	28

¹ The report of Surgeon-General Chisolm, of the Confederate Army, gives 55 gunshot wounds of the elbow treated conservatively, with only 22 cases of ankylosis, and 11 deaths. Of 103 gunshot wounds of the knee, only 21 ended in ankylosis. Other statements are equally surprising. As these results seem contrary to all experience elsewhere, I hesitate to accept them, and have omitted them from my tables. The figures were probably obtained from the records of surgeons who made out their returns in haste, and reported all injuries of the part as "wounds of the elbow," though the bullet had not, in all cases, opened the articulation.

EXCISION OF THE ELBOW FOR GUNSHOT WOUNDS.

AUTHORITIES.				CASES.	DEATHS.	MORTALITY PER CENT.
Med. and Surg. Hist. War of Rebellion.	Primary	.	.	318	68	...
" " " " "	Intermediary	.	.	196	69	...
" " " " "	Intermed. and second.	.	.	250	74	...
" " " " "	Purely secondary	.	.	54	5	...
Andrews and Woodworth, Surg. of Sherman's Campaigns .				7	3	...
Chisolm, Confederate Army	Primary	.	.	25	3	...
" " " " "	Secondary	.	.	36	6	...
Warren, " " " " "	Primary	.	.	1	1	...
" " " " "	Secondary	.	.	3	2	...
Esmarch, quoted in Gant's Surgery, p. 675	Primary	.	.	11	1	...
" " " " "	Secondary	.	.	29	5	...
Deutsche Zeitschrift. f. Chir. Bd. 1 und 2, {	Primary	.	.	12	3	...
Franco-German War	Secondary	.	.	64	16	...
Herrgott, Siege of Strasbourg	Primary	.	.	4	1	...
" " " " "	Secondary	.	.	7	5	...
Culbertson, op. cit., p. 495 . . . .		.	.	592	113	...
Totals				1609	375	23

In these tables, excision of the elbow is shown to be safer than amputation of the arm, for gunshot wounds. Conservative treatment shows even better results, on paper; but when we reflect that the slighter wounds (many of them merely buckshot wounds) were selected for conservative treatment, the apparent superiority of conservatism disappears, except for selected cases. Extraction of the loose fragments of bone, without excision, has been practised in a few instances with very favorable results; but there are no copious statistics which can be said to determine the value of the operation. At present, it is a matter for the individual judgment of surgeons.

As the tables establish beyond dispute that resection of the elbow, in proper cases, is as safe or safer than amputation of the arm, for gunshot fractures of the joint, and since by resection we save that most important member, the hand, we cannot doubt a moment about our duty, when the condition of parts admits of choice. The remarkable confusion and contradiction of opinion among surgical writers, on this point, may be seen from the following abstract:—

Chenu's statistics of the French army showed such a terrible mortality from this resection that Sédillot declared that it ought to be rejected from military practice.

On the other hand, the German surgeons in the Schleswig-Holstein war claimed a brilliant success with it. Hugelshofer,¹ after condemning partial resections as dangerous, asserts that complete resection is safer than amputation above the elbow, and remarks, "be the functional results good or bad, as you will, the preservation of a certain number of human lives which would have fallen a sacrifice to amputation of the arm, or to conservative treatment, must give the operation the first place in treatment of wounds of the elbow-joint." Heyfelder says that the results of resection of the elbow are brilliant, and he gives statistics² to show that partial resections are rather more dangerous than complete ones. Stromeyer recommends the operation. Demme and Salzmann say that resection of the elbow for gunshot wounds is three times as safe as conservative treatment. They put the mortality without operation at over sixty per cent.

In America, Ashhurst, Hamilton, and both the elder and the younger Gross approve the operation.

Hannover³ opposes the operation bitterly, declaring that of sixteen army cases, only one terminated in ankylosis, and that when ankylosis fails, the limb is useless, and burdensome to such an extent that the soldier at last desires it amputated.

¹ Deutsche Zeitschrift für Chirurgie, Bd. 111, S. 8.

² Lehrbuch der Resektionen, S. 246.

³ Deutsche Zeitschrift, Band 111, S. 7.

On the other hand, Hugelshofer says that a stiffening of the false joint is generally obtained, sufficient to give a useful limb. Lücke, of Berne, admits that absolutely firm ankylosis is not usually obtained; but affirms that a loose arm is better than none. Neudörfer holds the operation in high esteem. Billroth, of Vienna, says that of sixteen excised elbows in his observation, which remained movable, every one was more or less useful. Bickersteth, of Liverpool, says that of forty cases, thirty-eight survived, and all had useful limbs. Gant recommends the operation. Holmes considers resection probably more dangerous than amputation. Erichsen favors resection in proper cases. Max Schmidt¹ says that conservative treatment of gunshot wounds of the elbow is the most dangerous method, amputation the next, and resection the safest of all.

The above are samples of the contradictory precepts taught by the masters in surgery. Fortunately, we have a vast accumulation of tabulated experience to illuminate the question, which might otherwise be darkened by a cloud of wild and hasty conjectures.

The question of whether the resection should be primary, intermediary, or secondary, may be stated as follows: Like many other operations, this resection is safest when done at a very late period, after all inflammation has passed away, and when continued inaction has atrophied the limb. The next safest time is during the primary period, that is, during the first twenty-four hours. The most dangerous period of all is the intermediary one. The superior safety of the late secondary period does not, however, prove that the surgeon should delay the operation to get the benefit of that time. During this time of waiting, the grave dangers of expectancy are incurred, and a large number of lives are lost. The operation should be done, if possible, in the primary period; but if the surgeon see the case for the first time in the height of the acute, inflammatory stage, it may be proper, in some cases, to strive to abate the first fury of the inflammation, by the use of cold and antiseptics, before proceeding to operative measures. This is only an inference of the judgment, however, as there is no tabulated experience on record, to show whether more lives would be saved or lost by temporary delay in such cases.

Conclusions.—In spite of the former conflict of opinion, the main principles of treatment in gunshot wounds of the elbow may be considered as now settled.

(1) Slight wounds may be treated without operation, by cold, antiseptics, and free drainage.

(2) Wounds which destroy the innervation and circulation of the forearm sufficiently to threaten its mortification, indicate primary amputation.

(3) Almost all other cases demand primary resection.

(4) Complete excisions are better than partial ones.

Prothetic Apparatus for Cases of Excision of the Elbow.—Nothing can be more absurd than the opinion of Hannover, that a limb with a resected elbow is worse than useless if it fails of ankylosis. If the false joint be very loose and unmanageable, nothing is easier than to strap upon it an angular concave splint, which any tinman can make in twenty minutes, and the patient will have instantly all the advantages of ankylosis. A trifling additional labor will give the splint an adjustable joint, capable of being locked in any desired position, thus making the limb far superior to one which is rigid; besides, the false joint is, in many cases, capable of voluntary flexion and extension, making it far better than any stiff elbow, so that it is doubtful whether bony ankylosis is ever desirable, while it certainly is not so generally.

The destruction of the bone and of its covering is usually so complete.

¹ Schmidt's Jahrbücher, 1872.

that sub-periosteal resection cannot be practised; but in some cases a part, at least, of the periosteum can be preserved.

In cases where the condyles of the humerus are not destroyed, that bone can be cut across in its broad, thin part, and, by forming a false joint where its edge rests on the cut ends of the radius and ulna, it makes a most excellent, hinged articulation, which, as above remarked, is largely under the control of the patient's voluntary muscles, and which requires no splint to give it firmness. Some of these cases rank among the highest triumphs of surgery.

GUNSHOT WOUNDS OF THE WRIST-JOINT.—These wounds make serious mischief, and, notwithstanding the small size of the part involved, are attended by considerable danger. The pus permeates the complicated cavities of the articulation, becomes putrid, and can with great difficulty be washed or driven away. Increasing in quantity and putrescence, it often burrows among the tendinous sheaths and bursæ of the palm of the hand, and also works its way among the muscles of the forearm, causing both local destruction and general septicæmia.

In slight cases, conservative treatment is justifiable, but, in severer forms, excision of the joint is to be preferred. Amputation is not required unless the hand is actually dead. In cases justifying conservative treatment, the wound must be opened freely and drained with the utmost thoroughness, and antiseptic injections and dressings should be employed. All burrowing cavities should be opened freely and promptly, and should be kept well drained and disinfected.

Surgeons have not yet settled the question as to whether partial are more or less dangerous than complete resections; but the few statistics thus far gathered seem to indicate that partial resection may be safely resorted to whenever the condition of the parts renders it mechanically desirable.

The statistics of gunshot wounds of the wrist are very meagre, and the whole literature of the subject is scanty. The following figures, however, give the results of a considerable number of cases:—

TREATMENT OF GUNSHOT WOUNDS OF THE WRIST-JOINT.

AUTHORITIES.		TREATMENT.	CASES.	DEATHS.	MORTALITY PER CENT.
Otis	.	Expectant	707	54	8
Otis, Culbertson, and S. W. Gross	.	Excision	203	28	14
Otis	.	Amputation at wrist	18	2	11
Otis	.	Amputation at forearm	589	90	15

Conclusions.—The hand, after excision of the wrist, is of considerable value, though very far from equal to a sound member. The surgeon should therefore try his best to avoid an operation. If the injury is slight, conservative treatment is the best. If severe, excision is to be preferred, and amputation is to be reserved for such destructive wounds as leave no rational hope of saving the hand, or any part of it.

GUNSHOT WOUNDS OF THE HIP-JOINT.—These are most desperate injuries. Owing to the fact that they occur almost solely in adults (being rarely met with except in military practice), they are affected by the general law, that after that development of the hips which occurs at puberty, all injuries of the pelvic and adjacent organs involve a great increase of danger.

Besides this general law, there are mechanical reasons which add heavily to the peril of cases treated without operation. The bullet in reaching the joint passes through thick masses of fat and muscle, which close up behind

it. The result is that several ounces of comminuted bone and cartilage are imprisoned in the wounded tissues. Suppuration ensues, and the pus, finding no free exit through the nearly closed track of the bullet, burrows in every direction, causing vast abscesses about the hip, and far down among the muscles of the thigh, which are all filled with putrid fluids, and almost inevitably lead to fatal septicæmia. From these and other causes, nearly all gunshot fractures of the hip-joint are mortal, and science has thus far been unable to deprive them of their terrors.

There are four possible courses open to the surgeon:—

- (1) Amputation at the joint.
- (2) Excision of the head of the femur.
- (3) Treatment of the case as one of fracture, without operation.
- (4) Free opening of the articulation, picking out loose fragments, and using drainage with antiseptics.

The experience of the world alone can decide between these courses, and the results of that experience are briefly embodied in the following table:—

TABLE OF OPERATIONS FOR GUNSHOT FRACTURES OF THE HIP-JOINT.

OPERATION.	AUTHORITIES.	CASES.	DEATHS.	MORTALITY PER CENT.
Primary amputation.	Otis, Circ. No. 2, Surg. Gen. Office	76	75	99
Intermediary amputation.	" " " "	76	70	92
Secondary amputation.	" " " "	20	13	65
Primary excision.	" " " "	39	36	92
Intermediary excision.	" " " "	33	30	91
Secondary excision.	" " " "	31	11	85
Excision, time not stated.	Culbertson's Prize Essay, p. 41,			
Trans. Am. Med. Ass., 1876	. . . . .	121	106	89

From these figures it will be seen that almost all cases of gunshot fracture of the hip are fatal, no matter what the operation; but that resection is a little safer than amputation, and that all the secondary operations are safer than the earlier ones. The plan of treatment as a mere fracture, with no operation at all, has nominally better results than amputation or excision, but a close scrutiny into the recorded cases leads me to doubt whether the diagnosis as to the seat of injury has always been correct. In the haste of battle, many fractures of the trochanter, entirely outside the capsule of the joint, are liable to be set down on the reports as gunshot wounds of the joint itself, and thus vitiate statistical calculations.

In my own military service, I collected fourteen cases under the observation of myself and other surgeons, which were thus reported, and of the fourteen, four recovered and ten died; but, on a subsequent review of the records, such are the disadvantages of field service, I am unable to say, in a single instance, that the diagnosis had been made in such a way as to preclude all doubt. Eight cases are reported by Chisolm, of the Confederate Army, in our late war, as treated conservatively, and all proved fatal.

Dr. Otis,¹ after the most exhaustive review of the subject ever made up to the time at which he wrote, declared that he was unable to prove that a single patient had recovered, under expectant treatment, from a perfectly diagnosed gunshot fracture of the hip-joint. Otis, therefore, adopted the rule to operate in all cases. His words are:—²

Primary excisions of the head or upper extremity of the femur should be performed in all uncomplicated cases of gunshot fracture of the head or neck. Intermediate excisions are indicated in similar cases where the diagnosis is not made out till late, and also in cases of gunshot fracture of the trochanters with consecutive arthritis. Secondary

¹ Circular No. 2, S. G. O. 1869.

² Ibid., p. 123.

excisions are demanded by caries of the head of the femur or secondary involvement of the joint, resulting from fractures in the trochanteric region or wounds of the soft parts in the immediate vicinity of the joint. Expectant treatment is to be condemned in all cases in which the diagnosis of direct injury to the articulation can be clearly established.

Professor F. H. Hamilton, in view of the fearful mortality, doubts the correctness of this conclusion. Ashhurst thinks that excision is the safest course. Gant favors excision as furnishing almost the only hope.

Conclusions.—A careful study of the subject shows that the best treatment of gunshot fracture of the hip-joint is not yet scientifically determined, for, although Otis did not succeed in satisfying himself that any of the reported cases under expectant treatment were correctly diagnosed, yet we must remember that neither did he prove that they were *incorrectly* diagnosed. If even a few of them were what they were supposed to be, then the results were equal or superior to those of excision or amputation. Where the mortality of operations is such that from ninety-two to ninety-nine out of a hundred die, we may well hesitate, and hold our judgment in suspense, waiting for more light.

The present state of our knowledge is this:—

(1) Mortality of primary amputations 99 per cent.

(2) Mortality of primary excisions 92 per cent.

(3) Mortality of expectant treatment unknown.

It may be that Otis is correct in saying that, in all cases, a primary excision is, if possible, to be performed, but it is plain that we have no decisive, scientific proof of it. Under such grave circumstances, we should remember that we are not limited to a choice between amputation, excision, and pure expectancy, for there is a fourth course open to us.

When we consider that a large part of the mortality of cases under expectant treatment seems to be due to the septicæmia induced by putrid pus, confined under pressure in contact with fractured cancellous tissue, and burrowing in vast abscesses down the thigh, we readily see that, by resolute treatment, we may hope to avert much of this danger. If the joint, when first seen, were freely laid open, if dead fragments were very cautiously extracted, and if thorough antiseptic drainage and washing out were established, the results might probably be better than those of either amputation or excision. At all events, they could not be much worse, and, until this plan shall have been well tested, we cannot consider the discussion closed. There are certain cases, however, which afford us no opportunity for choice. These are fractures of the joint complicated with other injuries that destroy the life of the limb, without causing such an amount of shock as to render amputation altogether hopeless. In such cases, there is no escape from the necessity of removing the member.

GUNSHOT FRACTURES OF THE KNEE-JOINT.—Next to fracture of the hip, this is the most dangerous of all the gunshot injuries of joints. Unlike the corresponding injury of the hip-joint, the diagnosis presents no serious difficulty, and may generally be made out by the probe, by the insertion of the finger, or even by external manipulation. Few surgeons at first realize the terrible destruction made by the passage of a musket-ball through the knee. The limb looks fair and shapely, with only a small blue spot to mark the entrance of the projectile, and a slight rent of the skin at the wound of exit, and many a well-educated medical officer, in his first battle, feels the painful struggle of judgment in deciding to sacrifice a limb which shows such trifling, external marks of injury. If he amputates the limb, however, and dissects it, he will never hesitate again. The beautifully white and comely knee,

when opened, is found to be a mere bag of bony gravel, whose fragments are numbered by hundreds, and whose continued presence in the wound generally makes death certain; such is the typical gunshot fracture of the knee. Of course, however, there are a few slighter cases in which the border only of the joint is notched, and which, the injury to the bone being slight, are less desperate than others.

War furnishes great numbers of wounded knees, and, where skirmishing in forests is common, the right limb is usually the one struck, on account of the left one being so commonly sheltered behind the trees from which the skirmisher fires, exposing only his head with his right arm and leg.

The shock which attends wounds in the knee is less grave than represented by some authors, and is very much less than that experienced in comminuted gunshot fractures of the shaft of the femur. Few patients die from collapse, though great numbers perish from the later consequences of the injury. The history in typical cases, left to themselves, is as follows: There is almost no hemorrhage. The openings made by the bullet are closed to such an extent that the fluids find no free outlet. The joint, filled with hundreds of bits of dead bone and cartilage, becomes violently inflamed, and distended with pus, blood, and serum, in a state of advanced putridity. This virulent, septic fluid is retained under pressure, and absorbed into the opened, venous channels of the fractured, bony surfaces, thus producing septicæmia or pyæmia. From the supra-patellar segment of the joint-sac, the poisonous fluid escapes through the natural opening, so often present, into the great bursa above the joint, setting up septic abscesses which burrow the whole length of the thigh. Worn out by inflammation, pain, and blood-poisoning, the patient succumbs, in most instances, either to septic complications or to general exhaustion.

Treatment.—There are three possible modes of treatment for this terrible injury:—

- (1) Conservative treatment. .
- (2) Excision of the knee-joint.
- (3) Amputation at the lower third of the thigh.

The following tables give the statistics of the subject:—

GUNSHOT FRACTURES OF THE KNEE TREATED WITHOUT OPERATION.

AUTHORITIES.	CASES.	DEATHS.
Circular No. 6, S. G. O. (Otis)	308	258
Deutsche Zeitsch. f. Chir., Band 2, S. 106. (Franco-German War)	34	24
St. Petersburger med. Wochenschrift, 9 März, 1878. (Dr. Reyher,		
Army of Caucasus, Russo-Turkish War)	92	70
	<hr/> 434	<hr/> 352

Mortality of conservative treatment, 80 per cent.

Chisolm, of the Confederate Army, gives 201 cases of gunshot fracture of the knee-joint treated without operation, and with a mortality of only 60 per cent., which is 13 per cent. less than the mortality of amputation for the same injury. This is so widely at variance with the experience of the rest of the world that I hesitate to accept his figures, and have not included them in the table.

GUNSHOT FRACTURES OF THE KNEE TREATED BY EXCISION OF THE JOINT.

AUTHORITIES.		CASES.	DEATHS.
Circular No. 6, S. G. O.	(U. S. Army)	10	8
"	" (Foreign Armies)	12	11
Chisholm and Warren.	(Confederate Army)	5	3
Billroth's Briefe.	(Franco-German War)	22	19
Geissel.	(Franco-German War)	3	3
Reported to me by Dr. Carl Prægler.	(Franco-German War)	25	25
Herrgott.	(Franco-German War)	1	1
Culbertson's Prize Essay, Trans. Am. Med. Association		60	45
Cousin		44	38
Chenu.	(Franco-German War)	102	95
Lotzbeck		66	48
Kuster		101	66
		451	362

Mortality of gunshot fractures of the knee, treated by resection, 80 per cent.

It is evident that to some extent these authorities overlap, so to speak—that is to say, they have in a few instances included the same cases—but it is not possible from their documents to sift out all the repetitions. Moreover, as the deaths and recoveries are duplicated alike, the result is the same.

GUNSHOT FRACTURES OF THE KNEE-JOINT TREATED BY AMPUTATION.

AUTHORITIES.	CASES.	DEATHS.
Circular No. 6, S. G. O.	452	331
Mortality of gunshot fractures of the knee-joint, treated by amputation at the lower third of the thigh, 73 per cent.		

These tables may be summarized as follows:—

Gunshot fractures of the knee have given when treated:

- | | | | |
|--|----|-----------|------------|
| (1) Without operation, | 80 | per cent. | mortality. |
| (2) By excision of the knee, | 80 | " | " |
| (3) By amputation at the lower third of the thigh, | 73 | " | " |

It is evident that amputation is the safest course, as far as past methods of treatment are concerned, and common sense offers a good reason for it. Several hundred fragments of dead bone and cartilage imprisoned in a pierced synovial capsule, may be expected to cause death in almost all cases.

Dr. Reyher, of the Prussian army, tried antiseptic treatment in some cases, without any operation, and in others made an attempt by a sort of pump, or other mechanical device, to draw out the fragments before applying antiseptic dressings. His success was decidedly bad, as might naturally have been expected. He reports one case, however, treated on another plan with success. The joint was laid widely open, cleared from fragments, and then treated antiseptically, with the wound unclosed. One case proves nothing, but in view of the fact that the most successful method yet known, viz., amputation, has resulted in the death of nearly three-quarters of the patients, I think that the plan is worthy of further consideration and trial. It would certainly rid us of the septic dangers which destroy so many patients, and might possibly prove a great advance in surgical practice in cases of this destructive form of injury.

Conclusions.—The above suggestion is based on reason, but it has not been tried on a large scale, and until it has been thus tested, it remains among the things which are uncertain. At present, the profession is practically agreed on treating comminuted, gunshot fractures of the knee-joint by amputation, which should be primary, if possible. Where the joint is simply opened, or but slightly fractured, opinions differ to some extent, but Max Schmidt¹

¹ Schmidt's Jahrbücher, 1872.

advocates conservative treatment. Guthrie, in his Commentaries on the Crimean War, advocated delay when only the patella was moderately fractured. The late Dr. J. M. Woodworth, Medical Director of the Army of the Tennessee, in the War of the Rebellion, advocated amputation whenever the joint was opened, even without fracture of the bones.

In view of all experience, we must agree that, unless the plan of clearing the joint and treating it, wide open, with antiseptics, shall establish itself, we know of no treatment for comminuted, gunshot fracture of the knee equal to primary amputation; at the same time, the superiority of this method over conservative treatment is only seven per cent., and it is probable that in slight marginal fractures, and mere openings of the capsule, thoroughly antiseptic conservatism would be safer than amputation. Resection of the knee gives results fully as bad as conservative treatment, and, in the present state of our art, should be mostly rejected from military practice.

GUNSHOT FRACTURE OF THE ANKLE-JOINT.—This injury presents wide variations, from a simple rasping of the articular margin of the bone, to a total destruction of the joint and of the adjacent arteries and nerves. When the projectile traverses the articulation, it reduces the interior to a mass of bony and cartilaginous fragments, as already described in the case of the knee. This mass of bony gravel acts as a violent, mechanical irritant, causing burrowing, septic abscesses, caries, exhaustion, and often death. In some cases the tibia is shattered upward for several inches, and even where this has not occurred, the vessels are often destroyed so as to cause mortification of the foot. The circulation may in certain cases be sufficiently preserved to avoid gangrene of the foot, and yet, if the posterior tibial nerve be destroyed, the foot will be so nearly worthless that its preservation will be of doubtful value. For want of innervation, the sole of the foot will be prone to become ulcerated from the pressure of walking, and from the influence of cold in winter, so that the member will be far from being a comfortable appendage. The nature of the injury offers a choice between three methods of treatment:—

(1) Conservative management, with thorough drainage, and antiseptic injections and dressings.

(2) Excision of the joint.

(3) Amputation.

Conservative Treatment.—Of these three plans the first, or conservative method with antiseptic precautions, is not illustrated by any large number of published cases. I find, however, the following reports of conservatism without antiseptics:—

GUNSHOT WOUNDS OF THE ANKLE-JOINT TREATED WITHOUT OPERATION.

AUTHORITIES.	CASES.	DEATHS.
Drs. E. Andrews and J. M. Woodworth's cases from General Sherman's campaigns	9	1
B. Beck, Franco-German War	42	8
Report of Surg.-Gen. Chisolm, Confederate Army	23	6
Total	74	15

Mortality, 20 per cent.

Considering that these were cases largely selected for conservatism on account of their mild character, the mortality is very high, being much greater than that of resection, though less than that of amputation. Even in ordinary compound dislocations in civil practice, we scarcely dare to risk conservative treatment, but where a musket-ball has ploughed through the bones of the joint, simple expectancy is pure folly. Treatment without

operation, if adopted at all, should only be when the joint is simply opened, but not seriously fractured, and then it should only be with complete drainage and antiseptic management. Science has not yet proven whether or not the latter plan will be reasonably successful.

Excision of the Ankle.—The statistics of this operation are scanty. The mortality is nominally higher than that of conservative treatment, because, doubtless, severer cases have been selected for operation than for conservatism:—

EXCISION FOR GUNSHOT WOUNDS OF THE ANKLE.

AUTHORITIES.										CASES.	DEATHS.
Culbertson	.	.	.	.	.	.	.	.	.	45	12
Circular No. 6, S. G. O.	.	.	.	.	.	.	.	.	.	18	6
Stromeyer	.	.	.	.	.	.	.	.	.	1	0
Totals										64	18

Mortality, 28 per cent.

Amputation of the Lower Third of the Leg for Gunshot Wound of the Ankle.—Such is the imperfection of the science of surgical statistics, that it is next to impossible to procure any information on this exact point, for of all the thousands of cases of amputation of the leg which have been tabulated, scarcely any are minutely classified. Traumatic amputations just above the ankle have in general a mortality of thirty-two per cent., taking all kinds of practice together. The gunshot cases doubtless give a still higher rate of deaths, for the worst cases go to the amputating table, and operations in military surgery are generally more fatal than in civil practice. We may probably estimate the mortality of amputation above the ankle, for gunshot fracture, as at least thirty-five per cent.

Nominally, then, we should have the mortality of conservative treatment 20 per cent.; of excision 28 per cent.; and of amputation 32 per cent. For the reasons above stated, however, we cannot guide our practice by the footings of figures alone.

L. Legouest rejects excision of the ankle as improper. Hueter favors it in suppurating cases. Von Langenbeck recommends excision of the ankle for many cases of gunshot injury. F. H. Hamilton and A. Rose favor the operation in suitable cases. Pirogoff believed excision of the ankle in compound fracture to be safer than amputation, and placed conservative treatment between the two. Kade disapproves the operation. Gant, in gunshot wounds, generally prefers resection to amputation. Ashhurst favors excision. In the first edition of Holmes's System of Surgery, that author opposed resection, but in the second edition, changed his opinion, and favored it. Gross favors excision in proper cases. Erichsen opposes the operation. Druitt also opposes it.

These are specimens of the mass of contradictory opinions held by surgical authorities. It is evident that we can no more decide the treatment of wounded ankles by a consensus of opinions than we can by the bare footing of figures. Statistics and opinions are both valuable, but we must exercise reason and judgment in their use. Facts must settle the doctrines; and it is evident at a glance that facts do not justify the confusion of surgical literature on this subject.

The recorded cases show that there is no such desperate danger in conservative treatment, as should rule that method summarily out of existence. I think that all thoughtful surgeons will sustain the following general conclusions:—

(1) When the capsule of the ankle-joint is simply opened by the bullet,

without any fracture, or with only a slight scratch or groove along the border of the bone, it is perfectly rational to try conservative treatment with drainage, and antiseptic precautions.

(2) When the bullet has traversed the joint, and comminuted its interior, without shattering the tibia too far upward and without destroying the mechanism or circulation of the foot, or the innervation of its plantar surface, resection will generally save a useful member, with perhaps less risk than amputation. If conservative treatment should have been commenced, and in any case should present unfavorable and dangerous symptoms, secondary resection might be performed.

(3) If the foot be greatly shattered, or have lost its circulation, so as to be threatened with mortification, or have lost the innervation of its plantar surface, it should be amputated. Also if the tibia be shattered more than about two inches above the joint, it will necessitate amputation.

(4) Cases which, having been treated conservatively but without attention to drainage and antiseptics, finally present caries of the tibia, extending more than two inches upward, require amputation.

(5) Cases which in ordinary circumstances would require resection, may necessitate amputation if they are to be transported a long distance in ambulances, as it is difficult to manage a resected ankle in a jolting vehicle, on bad military roads.

GUNSHOT FRACTURES OF THE TARSUS AND METATARSUS.—I find in my military memoranda, twenty-one cases of this class, with one death. Primarily they are not very dangerous, but they often open up the complicated articulations of the tarsus, and set in action a suppurative synovitis which is of a somewhat unmanageable character on account of the impossibility of effectually washing out the cavities. The difficulty is a purely mechanical one, but none the less formidable, for the putrefaction of pus in the interior may give rise to dangerous complications. If the member be shattered beyond redemption, it must be amputated. If only certain parts be injured, sound judgment will often dictate a resection. The place and mode of either operation are to be settled on general surgical principles, such as guide us in civil practice.

If the bones be only perforated, but not utterly destroyed, conservative treatment will demand consideration. If adopted, it will be generally best to enlarge the orifices of the wound, scoop out, or in some other way carefully remove, all loose fragments, and then treat the injury thoroughly with antiseptics, and, if possible, with refrigerating applications. The field of battle, however, rarely furnishes anything colder than spring water for such uses. If the joints of the foot have only been pierced with bird shot, conservative, antiseptic treatment, without enlarging the orifices, will be worth trying. Buckshot wounds are more serious, but in favorable cases may be treated in the same way, if the projectile be not lodged within the member.

Bullets and buckshot lodged in the foot should be extracted, or they may lead to grave consequences, as in the case of General Garibaldi. Nélaton's probe, which won its reputation in determining the position of the ball in this case, is, though not absolutely useless, an unreliable and misleading instrument. When a bullet penetrates spongy bones, it leaves its channel studded with chips of lead rasped off by the rough bony surfaces, and these chips mark the porcelain ball of the probe in the same way that the bullet itself would do. A better instrument for diagnosis, in many cases, is the ordinary dressing forceps of the surgeon's pocket case. The tips of some of these forceps are so perfect, that they may be pressed down on any solid substance in the bottom of the wound, and made to bite out a chip of lead or of spongy

bone, as the case may be, sufficient to show the nature of the object. With this instrument I have discovered a bullet which had passed obliquely through the ala of the ilium, and had lodged itself inside, within the brim of the pelvis.

Gunshot wounds of the joints of the toes generally require amputation, but no special precepts are needed on this point. The principles of treatment are precisely those which govern us in the management of compound fractures from other causes.

DISEASES OF THE JOINTS.

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SYNOVITIS.

IN order that the movements of joints may be both painless and innocuous, nature has clothed the ends of the bones which form them with cartilage, a substance singularly devoid of sensation, and very irresponsive to sources of irritation. Again, in order to bind those bones firmly together and to limit motion both in direction and amount, nature has employed a material which, on being tightened, does not cause pain nor respond to moderate tension by over-action and hyperæmia. Both cartilages and ligaments, being destined to withstand pressure and traction, support those forces with considerable indifference; they are both very inapt to take upon themselves primarily any inflammatory action, though such action may spread to them from neighboring parts. Hence, although in the dissecting or *post-mortem* room we occasionally find that the articular cartilages in a knee, shoulder, or other joint of a senile subject, are rough, velvety, villous, or even eroded, yet we find in such joints no other change, and inquiry, when it can be made, will show that during life no articular trouble was observed. Even such slight appearance of disease as this, does not occur by itself in the ligaments. Their structure seems incapable of independent morbid action, although it slowly takes part and shares in such as affects the common areolar tissue which binds together its fibres and permeates its meshes.

The other two constituents of joints—bone and synovial membrane—are very differently circumstanced. The former, although not particularly sensitive to slight causes of irritation, is by its very function of weight-bearer and lever, exposed to many kinds of traumatism; by its mode of growth, to many formative diseases; and by its constitution, perhaps by the function of its medulla, it is peculiarly susceptible to the influence of dyscrasie—to those of youth, of middle life, and of senility. The synovial membrane is one of the constituents of the body most prone to respond rapidly to slight irritants by intense reaction, and that reaction is usually strongly marked because its products, concentrated within a cavity, again affect the synovial tissue itself with painful and generally injurious tension.

Hence it happens that whatever the theories¹ concerning the origin of certain diseases in the cartilages or ligaments may be, we do not find, either in the wards or in the laboratory, that joint-diseases begin in the most insensitive and sluggish constituents of the articular mechanism.

The morbid appearances and the symptoms of an isolated chondritis or

¹ The theories as to hip-disease commencing in the round ligament, and of arthritis deformans beginning in the cartilages, will be refuted hereafter.

syndesmitis, supposing that such affections could exist, are unknown. The pathologist never sees, and the surgeon never has reason to suspect the existence of, such diseases.

It may then be taken as assured that the only maladies with which we have to do, arise either in the synovial membranes or in the bones of joints; some which, like the so-called loose bodies of joints, are results of disease rather than disease itself, originate sometimes in one structure, sometimes in another; while certain other maladies may perhaps begin simultaneously in both structures—involving rapidly the more passive parts—so that all after a short time go *pari passu* through the various phases of disease. Such conditions must stand over for future consideration, since they will be better understood when the phenomena of synovial and of osteal disease have been fully explained.

Synovitis may primarily be divided into acute, subacute, and chronic. Probably no diseases in the whole range of pathology arise from so many causes as acute and subacute synovitis; thus violence, wounds, over-fatigue, exposure to cold, rheumatism, gout, syphilis, and the absorption of morbid poisons, all give rise to synovial inflammation, and bestow qualifying names on the disease. Moreover, these causes impress upon the symptoms certain characters which the surgeon should clearly recognize. For instance, certain of them are causes which affect the whole system, and then we find that the disease attacks several joints, or is “multarticular.”¹ The distinction must be borne in mind: “uniarticular,” acute or subacute disease is local; “mult-articular” maladies are constitutional.

The least complex forms of synovitis are those that follow some injury without open wound, but even in them certain distinctions are made.

SIMPLE SYNOVITIS.—*Simple synovitis* is also termed *sero-synovitis*, because the liquid in the joint, though excessive in amount, is not markedly changed in quality; it is a moderately clear, usually a rather thin synovia. But if the hurt have been more severe, and this applies especially to direct violence, as by falls or blows, this fluid is very likely to be mixed with and more or less deeply stained with blood; indeed, sometimes hemorrhage into the sac has been sufficient to cause the fluid to appear like unmixed blood, and so little is it diluted that in this *sanguinolent synovitis* the fibrin often coagulates out of the blood and floats in the cavity or falls upon its walls as shreddy flocculi. Again, in other cases, the cells cast off from the surface of the membrane—from the proliferating tissue²—and no doubt also a certain number of emigrated leucocytes, become sufficient in quantity to render a bloodless synovia opalescent, turbid, milky, even creamy; the fluid in the latter stage is indistinguishable from pus; but it is a surface pus, rather resulting from perversion of an excessive secretion than from any inflammatory tissue-disintegration; thus, for instance, an ordinary leucorrhœa may become mucopurulent or frankly purulent, yet without any deeper suppuration, which, did it occur, would probably be called pelvic cellulitis or parametritis. Volkmann terms³ this form of disease catarrhal; I have termed it *purulent synovitis*, in contra-distinction to *suppurative synovitis*—the much graver malady in which inflammatory pus is produced not merely on the surface, but in the substance of synovial and peri-synovial tissues, and even in the bones, by absolute

¹ Such diseases, although they may, after a certain time, implicate only one joint, always begin by attacking several others simultaneously, or in rapid succession.

² See, upon this point, Prof. Stricker's article in this *Encyclopædia*, Vol. I. pp. 26–30.

³ Die Krankheiten der Bewegungsorgane. Pitha und Billroth, *Handbuch der Chirurgie*, Band ii. Abtheilung ii. S. 493.

disintegration of tissue. There is then a clear pathological and clinical distinction between this last disease and the other forms already mentioned. No doubt there may be in exceptional cases phases of transition, the inflammation at times tending to pass from a mere surface condition to a parenchymatous affection, and occasionally actually doing so, or, on the other hand, retrograding. But since the two forms of disease are in their natural history as in their gravity so different, it will be advisable to treat in the present portion of this article of *simple synovitis*, including the serous, sanguinolent, and purulent varieties, and of *dry synovitis*, leaving the *suppurative* form to a subsequent page.

Simple sero-synovitis usually follows some slight injury, such as a blow or a sprain, but a condition which locally is indistinguishable from this affection may follow simple over-fatigue, exposure to cold, or even some error in diet. The first pathological change is no doubt hyperæmia of the synovial membrane, and this is very rapidly followed by increased secretion into the cavity of the joint, or, if the hyperæmia be pretty considerable, by simple exudation rather than by exaggerated secretion. The fluid is in such cases thinner than normal synovia, and very soon, if not quite at first, becomes a little cloudy. This haziness may be so slight that it cannot be perceived by mere inspection of the fluid; but, if it be allowed to stand a few hours in a conical glass, a deeper deposit than normally occurs in human synovia will be observed. Examination of this deposit by a microscope of sufficient power, shows it to consist of endothelial cells that have been cast off from the synovial surface, and of leucocytes. Any considerable increase of these cells renders the fluid turbid, milky, or creamy, producing all the stages and phases between simple and purulent synovitis.

Sometimes the fluid, instead of being thinner, is thicker than normal, viscid, glairy, and somewhat sticky; such states of the secretion are most common when the attack is rapid and severe. This condition is undoubtedly produced by an exuberance of fibrin in the fluid, and this fibrin is very apt to coagulate (I had almost said crystallize out) into little floating glomeruli, which may be perfectly clear and apparently structureless, looking like drops of white of egg floating in water. But if the excess of synovia contain many cell-forms, these become inclosed or entangled in the gelatinous concretæ, and they then appear hazy and white, like shreds of cotton-wool; or, again, if the disease be sanguinolent, the shreds are stained of a darker red than the surrounding liquid. These glomeruli are apt to fall upon and adhere to the articular parietes, cartilage or membrane, and there is great reason to believe, although I am not aware of any absolute proof of the fact, that their adhesion to a synovial surface produces at that spot a considerable amount of localized pain and tenderness. That they ever contract such organic adhesion as to become vascularized, and to aid in the formation of the hypertrophied fringes which will be described immediately, is doubtful.

In the mean time, and *pari passu* with the act of hypersecretion, the walls of the joint-cavity undergo certain changes. The capillaries immediately next to the surface are affected by those acts of dilatation and stasis which have already been described (Vol. I. p. 15 *et seq.*) as essential parts of the inflammatory process. The rapidity of cell-production on the surface increases; in some parts these proliferating bodies remain adherent; in others they fall away, leaving the basement membrane bare; while, at the same time, the parenchymatous constituents of the tissue increase, the whole, therefore, being thickened, and, in consequence of multiplication of its cell-elements, rendered slightly turbid. Thus, on looking at the surface of such a membrane, we see very plainly the blush of hyperæmia, yet not immediately on the surface, but

through the slightly misty medium of a thickened basement and epithelium, which, by gentle touches of the finger, may be shifted a little from side to side over the vascular layer beneath. More especially, as from their structure might be expected, do the fringes, the parts most liberally covered with epithelial coating, increase in size and thickness; even the extra-vascular, secondary sacculi¹ enlarge and multiply, so that the villous surface is more thickly set and coarser.

A little later, a change takes place in the appearance of the cartilages. They lose their bluish translucency and become of a cloudy, milky-white hue. This has, by the more enthusiastic and less eclectic of Cohnheim's followers, been attributed entirely to the immigration of leucocytes. This is certainly an error; for, though it is true, as I have seen, that here and there, just below the surface, a body having all the appearance of an amœboid corpuscle may be found, yet a section of cartilage in this state shows clearly that the change is in the cartilage cells, which, first near the surface, and afterwards more deeply, are augmenting both in size and number, while here and there those narrow, compressed cells, which line the free edge of the section, are seen to have in part fallen away; in some spots to have become fuller and rounder.

By retrogression of these changes, the inflammation may now subside; the superabundant cells, no longer nourished by an extra blood supply, either fall off while still sound and normal, or shrivel and become detached, simply as epithelial scales, or, still more commonly, undergo fatty degeneration and float away or burst. In either way they increase for a time, or at least prolong, the turbidity of the fluid; and in any case they assist in adding to the mucin of the joint secretion;² soon, however, this regains its usual qualities, both of transparency and siziness. A very analogous fate befalls the cells contained in the lately inflamed tissue; they degenerate, liquefy, and disappear.

But if the disease continue, there become added to the local changes, which we will not now further follow, certain neuro-muscular phenomena, difficult to explain, but of deep importance in the natural history of all joint diseases. The exact period of their first advent is difficult to fix with absolute certainty, but they commence very early, as witness the difficulty and pain experienced by a patient with even slight inflammation of the knee when he attempts to straighten the joint, and a sense of dull aching, like an imperfect cramp, which is so frequently felt about the lower part of the biceps femoris. As the disease goes on, these phenomena become more marked, and in advanced phases of the malady play a very important part in its ultimate termination. The condition is at first merely an increase in the tonicity of those muscles which move the joint, and chiefly of the flexors. Hence a constant tendency of the limb to become during inflammation more and more bent.³ Some writers suppose that both sets of muscles are contracted, and that the tendency towards flexion is due only to the preponderance of strength of the muscles which bend the limb. This is, however, not the fact, at all events in the earlier stages of a moderate inflammation. We may even question if, at that period, the extensors be not abnormally relaxed. Such a condition is generally very perceptible when the elbow is rather acutely inflamed: the biceps may be felt hard; its tendon rather tight; while the triceps is perfectly flaccid. But the most common instance is at the hip, where the tensor vaginae femoris, with the sartorius and the flexors of that joint, may be seen as a ridge and felt as a tight cord, at the upper, outer aspect of the thigh, while abnormal flaccidity of the gluteus,

¹ Rainey, Transactions of the Pathological Society of London, vol. ii. p. 110.

² Frerichs (Wagner, Handwörterbuch der Physiologie) and I (Diseases of the Joints, 2d edition, p. 22; American edition, p. 15) have shown the mucin of synovia to be derived from the trituration of endothelial cells in an alkaloid fluid.

³ A very few cases are on record of the contrary disposition, namely, towards extension.

causing flattening of the buttock and pendulousness of the fold of the nates, are among the most familiar signs of hip-joint disease. In ball-and-socket joints, both sets of capsular muscles, both inward and outward rotators, are thus contracted. This contraction is active, that is, is a shortening of the *σάπξος* of the muscle, and is, I believe, closely connected with that sensibility to false positions or over-strain of joints which is called "muscular sense," and which always calls into play an instantaneous, often tremulous, muscular effort. This contraction is not to be confounded with "contracture," as, twenty years ago, I named that secondary effect of continuous muscular shortening which consists of gradual shrinking of the sarcolemma and other mere fibrous elements to the abridged dimensions of the active constituents of the muscle. Several results follow this over-tension of muscles, and among them two are for our present purpose important: namely, a constant tendency of the limb to become more and more flexed, even to an abnormal degree, and an amount of pressure on each other of the opposing spots of cartilage, greatly conducing to their inflammatory ulceration. But it must be especially remarked, that both sets of muscles, both flexors and extensors, undergo atrophy; the limb above the inflamed joint wastes rapidly up to a certain point; the flexors chiefly by fibrous, the extensors by fatty degeneration.

At this point we may leave the anatomy of acute synovitis; that form of disease, be it simple or serous, sanguinolent or purulent, very seldom merges into suppurative synovitis, which, when it occurs, begins nearly always with an inflammation distinctly characteristic of suppuration, while a sanguinolent may become a serous, and that a purulent synovitis, the one merging into the other without any distinctive line of demarcation. Whenever suppuration of a joint follows what has appeared to be a less aggravated malady, the commencement has very generally been traumatic, the effused fluid strongly sanguinolent, the initial pain very severe, and pyrexia well marked.

DRY SYNOVITIS is a disease of very obscure etiology; it rarely attacks any joint other than the knee, is not unfrequently traumatic, and is most often observed in persons of a rheumatic constitution, though it is not to be taken as a mere rheumatic inflammation. Volkmann terms it croupous, and it certainly coincides with an absence of fluid contents or of marked swelling, and with the presence of a hard, leathery condition which can hardly be otherwise produced than by the coagulation of fibrin in and about the synovial membrane. We have seen that the persistence of pain in a limited spot of a joint which has suffered from an ordinary but severe synovitis is, in all probability, due to the presence of a coagulum, which, having formed in the fluid, has become deposited on the synovial surface; and the very severe suffering of dry synovitis appears to be due to a coating of the whole inner surface by a firm tough lining of fibrin, which glues together all the synovial folds, recesses, and fringes; nor does such deposition confine itself to the interior of the joint, but invades also the periarticular tissues; nay even the tendinous sheaths, fibrous or cellular, are likewise involved, so that the tendons become adherent for a considerable distance. A case of dry synovitis of the wrist-joint, which I unfortunately only saw rather late in the disease, was strongly characterized by firm tendinous adhesions a considerable distance up the arm and down to the phalanges. Generally this disease ends, even after long suffering, in resolution, occasionally with rapid absorption of the fibrin, so that but little stiffness may remain; but more often considerable stiffness, both intra-articular and extra articular, results. Occasionally the disease ends—indeed it has considerable tendency to end—in true ankylosis of such rapid production that it takes even watchful surgeons by surprise. The extremely rapid production of true ankylosis is very remarkable; it can only occur in one of two ways,

either the cartilages and their bony substratum must disappear, or they must coalesce and become ossified; such rapid dissolution of cartilage without suppuration is most unusual, while the fusion together of two cartilages is hardly recognized as a pathological process. Yet I have known a joint to become completely ossified in three weeks (22 days) after the first attack of the disease.

Another termination of dry synovitis, fortunately not a common one, is that after a fresh access of pain, probably a rigor, and a certain change in the character and type of fever, very acute suppuration will set in. The suppuration is very widespread, and appears to involve all the newly deposited fibrin; hence, according to the distance from the joint at which that deposit has occurred, the suppuration will involve periarticular and adjacent tissues, tendinous sheaths, and inter-muscular spaces. The character of the inflammation is severe, and quickly involves the vessels, thrombosis and blood poisoning following very rapidly.

SYMPTOMS OF SIMPLE SYNOVITIS.—It has been stated that synovitis of the serous, sero-sanguinolent, or purulent variety, may be produced by very various causes, and that certain differences in the symptoms depend upon the particular cause concerned. These differences, much more easily pointed out at the bedside than described in writing, consist in modifications in the proportional intensity of different symptoms; sometimes in additions or omissions from the general array of phenomena. The simplest picture of an ordinary synovitis may be drawn from that form of the disease which follows some injury, of a character not too severe. But before going on to the description of these various types, it will be well to lay especial stress upon the inferences to be drawn from the uniarticular or multarticular form of the malady.

It certainly may happen that by some fall or accident more than one joint may be injured; there may be multiple contusions or sprains just as there are multiple fractures; such an occurrence, however, could be easily verified, and the plain fact would lead to a ready conclusion. But when without a traumatism of this complicated description, a patient develops synovitis in several of his joints, we may come to the conclusion, or at least strongly suspect, that some constitutional condition has produced or originated the disease. The contrary does not hold good to quite the same extent, and especially cannot be assumed in chronic disease. Even when the case before us is acute or subacute, and at the time uniarticular, we must make sure of our ground; for, as we shall see hereafter, certain forms of malady begin with slight and transient, though very painful, manifestations in many joints, and end with more severe disease of one.

The four cardinal symptoms of inflammation, redness, heat, pain, and swelling, are all present in synovitis; but *redness* is in simple cases imperceptible, simply because the inflammation, though present in the deep parts, does not affect the cutaneous surface of the joint. *Heat* is, except in trivial cases, always present, though often to so slight a degree that this cannot be verified by the hand. Severe simple synovitis may cause a difference of 1.5° F., or as in one of my cases, 2.4° F., between the affected and unaffected sides.¹ If synovitis produce a greater rise of temperature, a suspicion should be aroused either that it is suppurative, or that it depends on some constitutional cause, such as rheumatism, gout, etc.

¹ I have not found thermometers for taking surface temperature trustworthy, the elasticity of the glass permitting a slight pressure to cause a considerable rise of the mercury, while the contrivances to prevent such an effect appear to reduce the sensitiveness of the instrument. My method is to apply the ordinary clinical thermometer for several minutes under a thick layer of wadding.

The *pain* of a sero-synovitis is not, as a rule, severe, while the limb is at rest, and especially after it has been motionless for some time. In other words, movement causes pain, which slowly subsides during quietude. The pain consists in a duller or sharper aching, according to the amount of tension, and at the same time in a sense of distension, fulness, or bursting; throbbing is very rare, its presence, or at least its prominence, marking a condition other than that of simple synovitis. Many persons, especially those of irritable or sensitive idiosyncrasy, complain of an uneasy aching, a dull sort of cramp about the flexor muscles or tendons. This is most commonly remarked while the patient is in bed, and while the limb is unsupported. But besides the general joint-pain above described, there is in every larger articulation a special place which is more painful and more tender than any other part. These painful spots will be referred to in connection with the peculiarities of tumefaction of each joint.

The *swelling* of simple synovitis, since infiltration of tissue is an intrinsic part of the process of inflammation, must occupy some space outside of the synovial membrane; but this external swelling is quite trivial in amount, and in the presence of much larger and greater tumefaction, is hardly or not at all perceptible. The enlargement on which the mind of the surgeon is fixed is that which is due to hypersecretion of fluid within the synovial sac, whereby it is filled out or distended to abnormal size.

The swelling therefore is fluctuating to the touch, and, according to the amount of effused fluid, more or less tense. If the joint be superficial, as the elbow, knee, or wrist, the fluctuation is, like the tumefaction, very easily detected; whereas if it be deeply seated, as for example the hip, both symptoms are obscure, and only to be recognized when the amount of fluid is very considerable. Certain very important points in semeiology arise from this distension of the deep parts of the limb. It is to be noted that every joint is crossed by certain ligaments and tendons, which leave between them parts where the synovial membrane is less covered. Most of these structures make, beneath the skin, prominences, which may be seen or felt, and which help to give what an artist would call "character" to the part; if they were eliminated the joint would look (again in artist language) "dumb" or "lifeless." Now this is precisely what takes place in slight synovitis: the distended sac, bulging out between the ligaments and tendons, obliterates their prominences, and the joint looks evenly rounded—dumpling-like, or dumb. But if the effusion become greater in quantity, a further effect follows: the interspaces between the ligaments and tendons protrude further than those structures, that which normally was a hollow becomes now a prominence, and *vice versa*. Hence a peculiarity of shape for each inflamed articulation, according to the position and form of the bands by which it is crossed.

We will take together the form of swelling and the special seat of pain for each important joint.

Shoulder.—The shoulder looks fuller and broader than that of the other side,¹ and the groove which separates this part from the chest is, especially at the upper end, very inconspicuous. These changes may best be seen by looking down upon the shoulders, the patient either kneeling or sitting on a low chair. In persons not too obese, there is at the back of the shoulder a shallow depression just below the acromion; this becomes filled up in synovitis. In severe cases the apex of the axilla is blunted, and to its outer side tumefaction may be made out. The especial seat of tenderness and pain is in front, just below the acromion.

¹ The natural differences between the right and the left arm must be kept in mind.

Elbow.—The elbow is a joint of complicated construction. The points at which the swelling of acute synovitis makes its appearance, are chiefly at the back. Thus the depression which lies on each side of the triceps tendon, and one which marks the place where the radius joins the humerus, become first obliterated and afterwards form rounded prominences; the line of the triceps tendon becomes a broad depression. Especially characteristic is the soft fluid swelling at the junction of the radius and humerus. A wave of fluctuation may be easily made to run from any one to any other of the above-named places. It is at the interval between the radius and the humerus that pain is chiefly felt.

Wrist.—At the wrist also, the swelling is chiefly manifested behind, namely on each side of the extensor tendons of the fingers, and between those of the thumb. This tumefaction gives to the lower part of the arm, behind, a bracelet-like enlargement very easily distinguishable from dropsy of the tendinous sheaths, for (1), its long axis is transverse to that of the limb; (2), it does not encroach on the carpus and metacarpus; and (3), it is neither fusiform nor bifurcated towards its lower end.

Hip.—The hip is rarely affected with pure, simple synovitis, which, when it does occur, is either traumatic or the result of over-exertion. The swelling in such cases hardly makes any appearance on the surface, but the condition is chiefly manifested by certain abnormal positions of the limb, which produce an appearance of either abnormal lengthening or shortening.¹ When distension of the synovial membrane is sufficient to cause perceptible swelling, it is found behind the great trochanter and in the lower part of the groin, that is to say, at a place below the middle of the line separating the thigh from the abdomen. If the patient be thin, fluctuation from one to the other of these spots may be detected. Another place where tumefaction can be felt, is in the angle between the thigh and the perineum, a little behind the tendon of the adductor longus muscle. This disease gives rise to a good deal of pain, which runs down the thigh and is often referred to the knee. Two adjacent bursæ may, when inflamed, produce symptoms which on inadequate examination simulate hip-disease. One of these lies beneath the tendon of the ilio-psoas, and upon the head and neck of the femur, as low as the lesser trochanter; it frequently communicates with the synovial membrane of the hip-joint. When it is a separate sac, and becomes inflamed, it gives rise to a considerable swelling in the lower groin, while the post-trochanteric fossa is unaltered. Flexion of the thigh on the abdomen is painless, while extension, especially when combined with inward rotation, is intolerable. The other bursa, a very large one, is placed under the gluteus maximus; when distended, this bursa produces a broad, rounded swelling, which occupies more than the parts behind the great trochanter; indeed, the soft parts directly over that bone are increased in mass, so as more effectually to conceal it.

Knee.—The knee, being both large and superficial, is more often affected with the various forms of synovitis than any other joint of the body, and the disease is owing to these two peculiarities very easily detected. Normally, the tendon of the rectus, the patella, and its ligament, form along the middle of the joint, in front, a varied and undulating projection, on each side of which are depressions. When the synovial sac becomes filled, these latter are obliterated. When very tense, they become prominent, so that what in health are projecting parts, are transformed by a severe acute synovitis into hollows. More-

¹ These postures will be fully explained when I come to speak of hip-disease.

over, the accumulated fluid presses the patella a little way forwards, away from the femoral condyles, so that when the surgeon presses it sharply back, it knocks against the deeper bone very decidedly, and at the same time the swellings at the side become still more prominent, by displacement of a wave of fluid from the front; fluctuation is thus absolutely visible. Also, when any considerable amount of hypersecretion is in the joint, it protrudes into the popliteal space, which thus becomes shallow or even obliterated. An inflammation of the bursa patellæ causes a semi-globular or conical prominence in front of and concealing that bone. It can hardly be mistaken for swelling of the joint itself, and another bursa, situated under the ligamentum patellæ (occasionally communicating with the knee), produces very localized pain, and a swelling which resembles enlargement of the tubercle of the tibia.

The special seat of pain, in the case of this joint, is a spot in front of the inner condyle, a little inside the edge of the patella.

Ankle.—The ankle-joint is not unfrequently the seat of acute synovitis, but rarely of a severe character; the disease either becomes chronic, or quickly disappears. The swelling is chiefly in front of the malleoli, more especially in front of the outer malleolus. A less degree of enlargement is observed behind, but the extensor tendons are pushed a little forward, so that the whole tumefaction stretches from behind one ankle bone around the limb to the back of the other. This characteristic serves to distinguish the affection from the effusion into tendinous sheaths, which so frequently follows sprains or exposure to cold. In synovitis, the swelling runs like an anklet around the limb; in the tendinous affection, it runs lengthwise on the leg, and encroaches somewhat on the instep.

The *constitutional symptoms* of simple synovitis are very slight. If the attack be traumatic, and be accompanied by bruising, or if the pain be very severe, some slight pyrexia is usually present, but it generally subsides rapidly. Continuance of pyrexia indicates that the disease is assuming a more or less purulent character, but even then the thermometer is very little over 100° F. A higher temperature, 101.5° to 102.5° F., marks a more severe condition; it may be suppurative synovitis, or perhaps rheumatism. The former is rarely grafted upon the simple form of the disease, and is preceded, as a very general rule, by more severe pain, and more especially by rigors.

SYMPTOMS OF DRY SYNOVITIS.—The symptom of dry synovitis, which, by its prominence, masks all others, is pain. This disease rarely attacks any other joint than the knee, and, although it is not at all like the joint inflammation of acute rheumatism, it has very marked preference for persons of a rheumatic constitution. The commencement is gradual, the patient suffering from only the ordinary, not very severe pain of an ordinary synovitis; the fluctuating swelling, already described, is however but slightly marked. After a few days this pain, instead of decreasing, becomes more severe; probably a sleepless night of considerable suffering is the first intimation of some more violent attack. Probably the surgeon, having been told of this pain, will expect to find a greatly swollen joint with signs of impending suppuration, and will be somewhat surprised to see but very little enlargement, no redness, and no appearance of increased fluid in the synovial sac. Even the appearance of swelling which he observes, is not as great as it looks, as may be verified on measurement, but in this form of disease, wasting of the muscles above, is extremely rapid—more so than in the serous variety—and this causes the joint to look larger than it really is. The form of the swelling is very different from that which has been described above; it is not so round,

with protuberances between ligaments and tendons, but has a peculiar, angular, or square look. To palpation, it is not soft and fluctuating, but hard, elastic, and leathery. If the finger be passed down the limb from the healthy to the inflamed parts, it perceives, on reaching the latter, a distinct, rounded edge to the tumefied joint. The skin very soon becomes rather tightly drawn, and then often assumes a browner shade than the part above and below; that is, the parts immediately over the joint are a little browner in dark, and a little yellower in blond individuals.

In severe cases palpation must be very gently employed, as it generally produces severe pain; although I have seen two cases in which pressure by the whole hand was painless, though by the finger-tip it was unbearable. But the pain which the patient complains of is not mere tenderness—it appears agonizing; and although it is described as constant, there must be intervals, since he generally gets some sound sleep, perhaps two or three times in the twenty-four hours. Even those who insist that the pain is constant, nevertheless speak of paroxysms of greater severity; but—and this a very marked peculiarity—in spite of the severity and duration of pain, the health suffers but little.

The *constitutional symptoms of dry synovitis*, although more marked than those of the simple disease, are by no means commensurate with the amount of pain; indeed, it is chiefly upon the contrast between the intense pain which the patient complains of, and the comparatively low temperature, the absence of rigors, and the almost clean condition of the tongue, that the surgeon will rely for his diagnosis; or, at least, it will probably be this disparity that will first lead him to believe that the joint is not suppurating. Very generally, too, the appetite remains good, so that in the intervals of ease, or of comparative ease, food is taken with relish. As the small amount of pyrexia would indicate, there is no excessive thirst; although the pain is described as incessant, yet, as already remarked, but few cases of continuous pain really occur; nearly all patients obtain, during the twenty-four hours, some quiet sleep, even without the aid of opiates.

The skin is generally dry, but occasionally profuse perspirations of acid odor occur; and in some cases these are nightly, and very excessive. The urine is high colored, but not particularly scanty; it frequently, on cooling, becomes covered by an iridescent film. The most usual deposit is deeply stained lithate of ammonium; pure uric sediment is rare. If, after this disease has lasted some days or weeks—and its duration in this form is very uncertain—the thermometer rise suddenly to over 102° Fahr., more especially if such elevation have been preceded by a sharp rigor, the probability is that the type of the disease is changing, and that the suppurative form is about to appear. This change, although in my own experience very unusual, certainly does occasionally take place.

TREATMENT OF ACUTE SIMPLE SYNOVITIS.—Since, as we have seen, the constitutional symptoms of simple acute synovitis are very slight, so it is evident that but little general treatment is required. Three points should always be considered: the state of the bowels, the condition of the urine, and the amount of pain. With regard to the first of these, I would recommend that, unless the action of the bowels has been during the previous few days quite free, an aperient, or in some cases a purge, should be administered. The choice between these two somewhat different remedies should be based on the following considerations: aperients only should be given if the patient be moderately spare, if he have not a full abdomen, and if the affected joint be of the upper extremity. But if the patient be rather stout, and have a full, large abdomen, it

may be wiser to give the stronger remedy; and if a joint of the lower limb be involved, and especially if the individual be in the habit of taking much exercise, a purgative should be employed, since he must certainly be debarred from his usual active habits, and very likely must be confined altogether to a bed or couch. The choice of particular drugs, whether cholagogues, hydragogues, or mere alvine purges, must depend on the state of the tongue, the color of the conjunctivæ, and other principles of general medicine.

Many patients, suffering even a mild inflammatory attack, one which barely raises the temperature, show at once some constitutional response to the disease by a rather scant and high-colored urine, which, in some persons, deposits uric acid. In such cases it is well to give some diuretic, probably—indeed certainly if there be uric acid deposit—combined with an alkali, nitrate and carbonate of potassium, with nitrous ether, or an effervescent draught containing citrate of potassium and ammonium; while, if the uric acid deposit be pretty copious, a little wine of colchicum may, for two or three days, judiciously be added.

It is rare that the pain of sero-synovitis is sufficiently severe to need opiates. Traumatic cases may, however, require these remedies for the first night or two. The most reliable indication for such medication is the amount of pain, which is not merely to be regarded as a passing and temporary infliction. Pain produced by inflammation is, I am sure, a direct irritant, and a cause of its persistency. Opium or morphia, by the mouth or subcutaneously, are the most reliable remedies; but smaller doses may be rendered sufficient by combination with atropia, or with bromide of potassium; or, again, if the fever be pretty well marked and the skin dry, with a small quantity of tartarized antimony. Chloral as a remedy for pain is unreliable, or even useless. Another drug should be mentioned. I have rarely had occasion to use it, but when it has been called for I have found it valuable, especially when the fever has run high. I refer to aconite, which in these cases is most useful; its mode of administration and its action will be more fully discussed when the treatment of dry synovitis is under consideration.

The *local treatment* of acute or subacute synovial inflammation,¹ consists, in great part, in rest. This word does not merely mean that the patient is to abstain from active exercise and keep the limb motionless; indeed, such voluntary abstention from, such guarding against, movement, is often the very reverse of physiological, producing, if not quite at first, yet after a certain interval very considerable, and frequently painful, muscular effort. To keep a limb really at rest; it is necessary to secure it in some stiff support, which shall prevent movement independently of, and in spite of, muscular action. But before doing this, it is necessary to consider the position of the part. If the surgeon be called in while the disease is still quite recent, he will find the joint in no forced position, and, in all probability, easily movable without any marked pain. But if called in later, and more especially if the synovitis have come on rapidly with unusual severity, he may find the part in strong flexion, from which it cannot be brought without very considerable violence and the infliction of much pain. The posture is, as we have seen, forced upon the part by neuro-muscular phenomena, which, though difficult of elucidation, are, with extremely rare exceptions, constant. Now this flexion, especially if to a considerable degree, is not only a result of inflammation, but it comes to be a cause of its continuance, and is always productive of pain. Moreover, the surgeon, prudently looking to the future, will remember that the disease may get worse; may, exceptionally, however, in mere simple

¹ Though most chronic inflammations must be likewise so treated, yet as there are certain exceptions, the word "chronic" is omitted in the text.

synovitis, pass through various phases of exacerbation until it end in aneclerosis; and that, therefore, it will behoove him to place every inflamed joint in or near such a position as will leave the limb most useful. This position is, fortunately, that which is most advantageous for immediate treatment. So important is posture in the management of joint disease, that it certainly is unwise to temporize. If, when the surgeon is called in, he finds the limb in a bad position, and so fixed that he cannot change it by mere traction, without producing severe pain and muscular spasm, it becomes his duty to administer an anæsthetic, and to place the joint in a good position and on a proper splint while his patient is unconscious.

But certain joints are, if they are to be aneclorosed, most useful when flexed; others, when straight or nearly straight; and it fortunately happens that these particular postures are those that are best for curative treatment. Therefore each joint has its own angle for fixation, both for treatment and for use.

The *shoulder* should be placed so that the elbow lies a little in front of the median plane of the body, and a little separated from the flank, while the hand may be supported against the thorax of the sound side. A wedge-shaped cushion, which goes by the name of Stromeyer,¹ may be used for this purpose; or, since, that is rather liable to slip, two pieces of wood may be placed together in a V shape, inverted, and retained by a metal bracket. One of these is to lie upon the side, the other supports the arm; this latter is to be about three or three and a half inches broad, and is to reach from the borders of the axilla to the inner condyle. The other is to be of the same breadth above, but may gradually widen towards its lower end. To use it, place it when well but not too thickly padded, with its apex in the axilla; bind, by circular turns of a bandage, the one part to the chest, taking care that the other leg of the V shall be in the desired position, and that one or two turns of the bandage shall run from the angle, across the chest and back, to the sound shoulder. When this first portion is well secured, lay the arm on its appropriate part of the splint, and bind it in its place.²

The *elbow* is best kept at a right angle, the hand so placed that the thumb lies upward. For this joint a moulded splint of poro-plastic felt, or of leather, is preferable to a flat one of wood. It may be applied either to the inner or outer side.

The *wrist* must be kept straight; an ordinary "dish" splint answers the purpose sufficiently for this sort of case, but a thick pad is to be placed under the palm so as to allow the fingers to be slightly flexed.

The *hip* too must be kept straight, and should also be slightly abducted. The unfortunately common affection known as hip-disease will be discussed in another part of this article; but it is necessary to remark here that that disease very rarely begins in acute synovitis, which is usually a much milder affection, running its whole course, under good treatment, in about ten days. When the surgeon is confident in his diagnosis of a mere synovitis coxæ, he may rest content with placing his patient on his back in bed, and employing weight extension, as in cases of fractured thigh.

The *knee* must be placed nearly straight, and the foot a little in flexion; theoretically, a perfectly straight joint would be preferable, but practically that posture does not avail, because it very soon becomes painful, and because the strain on the Winslow's and posterior crucial ligaments keeps up the inflammatory irritation. As to the sort of splint to be employed, many different opinions prevail. Some surgeons, more especially in Germany, prefer the

¹ See Figs. 275, 276. Vol. II., page 160.

² In cases of obesity, and also in very thin subjects, it is better not to let the two boards quite meet, but to keep them nearly or quite an inch apart at the apex of the splint; there must then be two metal brackets, one at each end.

immediate use of some immovable apparatus, such as plaster of Paris, water-glass, or gum and starch. I prefer, for many reasons, a removable splint, and in my own practice have found that known as the Amesbury splint to answer well. This consists of two metal gutters, one for the thigh and one for the leg, hinged together, and having behind a screw to change the angle. There is also a footpiece, which can be brought nearer or farther from the hinge according to the length of the patient's tibia; its angle, also, can be changed. It is important to make sure that the back of the joint does not lie a little off from the splint, so as to allow, for instance, the easy introduction of a finger into the popliteal space. I have seen many a limb rest on or about the middle of the thigh, the calf, and the foot, while the joint has not been fairly on the splint; the rest under such a vicious arrangement is very imperfect, and much pain, generally attributed to the disease, is in reality due to the defective treatment.¹

The *ankle*, when inflamed, should be so placed that the foot is at a right angle with the leg, and care must be taken that the former does not roll either inward, or, what is more usual, outward, so that the weight falls on either lateral ligament. If the disease be pretty severe, the knee also should be immobilized, otherwise the plastic-felt, or leather splint, moulded to the outer side of the leg, is sufficient.

The cause of my preference for removable apparatus is that it gives opportunity for local treatment, which is prevented by the use of plaster of Paris, or other such means as cover in the joint. Concerning local remedies and their value, there is considerable difference of opinion and of practice in different parts of the world, since varieties of habits and surroundings produce in our patients conditions and states of body essentially unlike. This remark applies more especially to the desirability or otherwise of *topical bleeding* by leeches or the cupping-glass.² To justify any local loss of blood as a remedy for joint-inflammation, two conditions must be coincident: one a severely acute, local inflammation, the other a sthenic constitution. But though the coincidence of these may justify blood-letting as productive of no injury, we must also ask ourselves if it will do good. Now, though I only use this remedy in severe cases, and most generally in those of traumatic synovitis which have come under treatment while the disease is yet developing, yet I am convinced that in such cases it often retards or prevents further increase, and arrests the disease at the point it has then reached. It is most valuable if the joint be a superficial one, such as the knee, elbow, or wrist. The leeches should not be applied immediately over the synovial membrane, but to a point above, where the larger veins which receive blood from the articulation are near the surface. By the former method, the superficial capillaries merely are uselessly emptied; by the latter, we probably deplete the deeper venous radicals, those vessels, namely, in which inflammatory retardation and then stasis of circulation first occur. The time at which this remedy is most useful, is at any period of an acute attack in which swelling, already pretty considerable, is still on the increase, the joint becoming larger, more tense, and more painful. A repetition of bloodletting, or even its employment at a later stage of the disease, is to be deprecated as worse than useless.

A more reliable remedy, and one producing more rapid results, is *evacuation of the joint*. All observation shows that pain is in very close, if not in exact proportion to the amount of tension; moreover, it is to be noticed

¹ Other forms of splint will be mentioned hereafter.

² The cupping-glass has, at all events in London, fallen into almost complete desuetude. In the earlier days of my professional life, that is, about thirty years ago, several persons in the metropolis made very good incomes simply by cupping; a considerable portion of their practice was in cases of inflamed and injured joints.

that while severe sprains or certain partial dislocations are very generally followed by severe synovitis and distension; yet complete luxations, accompanied as they are by laceration of the synovial membrane, although more severe, are not accompanied by any synovitis. The inference is fair, that accumulation in, and distension of, the joint cavity by the hypersecretion, is that which prolongs and gives severity to the disease. This distension also, if allowed to continue, is followed by certain evils, such as laxity of ligaments and of periarticular tissues, that render the part for a long time weak and painful; and therefore, for many years past, it has been my practice to puncture and empty all acutely inflamed joints, when distension has been marked. For this purpose, a sharp, tubular needle (an exaggerated subcutaneous-injection needle) is all that is necessary;¹ but, for precaution's sake, an India-rubber tube of $\frac{1}{4}$ inch capacity and about three feet long, may be added. The mode of performance is this: an elastic-webbing bandage is to be lightly rolled on the knee, leaving between two turns the part to be punctured, which of course will be salient. Here the needle, clean and purified by immersion in carbolic oil, is to be thrust in by a quick, dexterous stab, and pressed well home into the cavity. I have very often done this without any tube, believing that the pressure of the elastic band would quite prevent the possibility of the entrance of any air; nor have I ever had reason to distrust the method. Nevertheless, if extra caution be desired, a tube as above described may be secured to the collar of the needle, and filled by suction with a four-per-cent. solution of carbolic acid. This tube is held a foot or two above the level of the joint, and, after puncture has been effected, is gradually lowered, letting its lower end be received into a vessel containing the same solution; or, taking care to avoid any sharp bend, its end may be kept a little raised, so that always some fluid remaining in the tube may act as a trap or valve against any possible admission of air. By this means, we may draw from a knee, from four, even to six ounces of fluid; from a shoulder, from two to three; from an elbow or an ankle, two ounces is a large quantity. But it may be that, though the evidence of fluid in the joint cavity is complete and conclusive, yet none will flow through the needle on account of its viscous nature, or from the canula becoming clogged with flocculi; under these circumstances, a suction-vacuum may be applied, though it will not often be successful; it is better to withdraw the needle, and, passing into the same puncture a fine tenotome, to make in the synovial membrane a pretty wide subcutaneous incision, whereby the excess of fluid soon drains away into the neighboring tissues and leaves the hitherto distended joint empty and flaccid.

The result of this evacuation is immediate and strongly marked. Tension, of course, ceases at once, and pain very rapidly, sometimes immediately, disappears. Thus the chief symptoms of synovitis vanish, though it can hardly be that the inflammation itself is so rapidly subdued; but the chief cause of its severity and persistence having vanished, its subsidence, as a rule, very soon follows. I have known cases in which the swelling, to a certain extent, returned; in such, the amount of fluid in the joint is usually very small, and the tension *null*. In a very few instances the synovial sac has filled again, tension has returned, and the evacuation has been repeated; but I have never had occasion to resort to this procedure a third time.

Another remedial resource is *extension* of the limb,² that is to say, subject-

¹ There is no occasion for the suction or aspirating apparatus of Dieulafoy; indeed it often leads to disappointment.

² There is here some little difficulty in nomenclature. The term as thus applied does not mean straightening of the limb, but traction in the direction of its long axis. Volkmann and, following him, many German writers call the method "distraction."

ing the diseased joint to a certain traction in the downward (anatomically downward) direction, either by means of weights or other force. It will not be necessary to describe the various modes of applying extension here, since the method must be more fully referred to in the section on chronic inflammations, where it is, in my belief, more useful than in the acute forms of disease. Nevertheless, it must in justice be pointed out that many writers of great authority—Volkmann, Langenbeck, and others—speak in high praise of extension as a direct antiphlogistic, and that they, like many others, consider that the secret of its virtue lies in enlarging the cavity of the joint, and thereby diminishing intra-articular distension. But this supposition is evidently incorrect; the only way in which extension could enlarge a joint cavity would be by drawing the bones asunder, that is, by elongating the ligaments. Acute synovitis, if considerable intra-articular distension be permitted to continue, leaves behind a very detrimental laxity of ligaments; if to this were added such powerful extension as would elongate them, still greater trouble would follow. Too powerful extension may be, and, as I have observed, has been, followed by such an injurious result. But such moderate traction as is ordinarily employed, does not increase, in fact, it rather decreases the joint-space, by causing a certain tension of the skin.¹ My own belief is, that the value of extension is to be found in its resistance to the morbid muscular contractions to which I have already referred. Muscular effort, whether voluntary or involuntary, may always be tired out by continued resistance, and, if this resistance be of a sort insusceptible of fatigue, it must, in a certain time, obtain the victory. We shall see, hereafter, that the obstinacy of many joint inflammations is in great part due to the excessive mutual pressure of surfaces, produced by the muscular contractions. If we overcome these, we in so far place the part in a better position for getting well. The indication, therefore, for the use of extension is not the fulness of the synovial sac, but the advent of well-marked neuro-muscular phenomena, and it may be thus used, whether or not the joint has been previously emptied.

In the absence of these symptoms, we shall probably find that evacuation of the synovial sac leaves a certain inflammatory state behind, and we may then take further measures to subdue this condition. Of these measures, no doubt the use of *cold* is the most potent for all but very deep joints. It must be rather intense; the mere application of water, or of an evaporating lotion, is inoperative, but ice kept on the part for a considerable time has a very decided effect. The easiest mode of application is to place small pieces of ice in a wide-mouthed India-rubber bag, and to suspend it in contact with, and partly surrounding, the joint, from the wires of an ordinary bed-cradle. Probably the first contact, driving blood from the surface, causes some greater fulness of the synovial vessels, but in a little time the deeper tissues also become chilled, and, save in such deep articulations as the hip, the whole membrane, with the peri-articular structures, becomes pale and bloodless. In the use of this remedy, however, some caution is necessary, for in persons about or beyond middle life, and even in young people of rheumatic habit—especially in those who have suffered from acute rheumatism—cold, though at first beneficial, is very apt to leave behind a condition of chronic or recurrent inflammation, and often, even without demonstrable inflammation, a tender and painful condition of the joint, a stiffness and lameness which are very difficult of cure.

In such persons, *heat* is a preferable remedy; it must not be mere warmth,

¹ I would especially refer those who are curious on this subject to some excellent work by my friend, Dr. Karl Reyher, in the *Deutsche Zeitschrift für Chirurgie*, Bd. iv. S. 26 und folg.

but absolute heat of a dry kind, and of as high a temperature as the patient can bear without pain. But it does not seem to me that its long continuance is of advantage; it may be used, according to its effect upon the pain, for from half an hour to an hour at a time, and may be repeated two or three times in the twenty-four hours. The simplest mode of application is by means of salt heated in a frying-pan, or in the oven, and placed in flannel bags—of which two should be provided, so that a fresh, hot one may replace that which has cooled. I suppose that this application acts as a derivative, for since tenderness of the surface shows hyperemia of the superficial vessels, it is probable that the deeper parts are correspondingly made emptier.

Blisters or other *counter-irritants* are not advisable during this stage of acute synovitis, but at a later period, when the object sought for, is, as we shall see, different, they may be properly employed.

The treatment above described ought to quite suffice for subduing acute serous, sanguineous, or even purulent synovitis, and will be found efficient for that purpose; but patients of gouty, rheumatic, or even of strumous habit, may receive an injury resulting in synovitis, and the disease, becoming chronic, may, mingling with the constitutional taint, put on the characteristics of gouty, rheumatic, or other such disease. Such subacute or chronic endings of the disease are often unnecessarily prolonged, because the particular habit of body is either overlooked or too lightly regarded; we should always, if not from the first, still very early, consider the possibility of such complications, and we may then have to use, what need not be considered here, the appropriate remedies for these special forms of joint disease.

But even if this do not occur, the *reliquæ* of a severe attack of acute synovitis may be very lingering and very troublesome. Often, if considerable distension have been allowed to continue for some time, a certain laxity will render the part insecure, with a disagreeable sense as though something might readily slip out of place, while yet the joint is stiff and moves uneasily. Or again, after those eases in which the fluid is less, but the heat well marked—especially after purulent synovitis—there is left very considerable stiffness; every movement is more or less painful, the joint grates or crackles, and after use, as, for instance, in bed at night, it aches and will not lie comfortable in any position. If a little more exercise be taken, it not only is more painful, but may feel very useless, and may even swell again. In these states *counter-irritation* is often valuable. The milder counter-irritants, such as tincture of iodine, nitrate-of-silver solution, and others, may be applied directly over the joint; but stronger remedies, such as blisters, should be placed a little distance away, and generally above the synovial membrane, and, if possible, over the nerve or some of the nerves supplying it. Thus, for the elbow, a blister occupying the inner aspect of the arm, just above the condyle, will do more good than if applied elsewhere; or if we wish to blister the knee, the application should be made above the joint, over the lower part of the internal vastus, because here is situated a plexus between the crural and obturator branches, both of which send twigs to the knee. But I would not advise that blistering be carried far, and I myself prefer to stop short of vesication, repeating often what is little more than the use of a rubefacient.

Another powerful means of causing absorption either of parietal thickening or of remaining fluid effusion, as also of giving firmness to a relaxed joint, is compression. The mode in which I prefer to apply it is either by an elastic bandage or by strapping-plaster, according to certain circumstances. If there be mere weakness with thickening, with no or very little fluid effusion, compression by strapping-plaster is best. The adhesive material may be either simply the emplastrum resine or the mercury and ammoniacum plaster of the British Pharmacopœia; the emplastrum calefaciens is sometimes valuable, and

the emplastrum plumbi iodidi, save in gouty constitutions, may aid in promoting absorption.¹ The strapping should be cut in strips of about three-quarters of an inch in breadth, and evenly applied from below upward with a certain amount of tightness and pressure. But if there be some little fluid in the joint, it is better at first to use elastic compression; this of course may be done by sundry means, as, for instance, by the elastic caps which are made for all the important joints of the limbs; but I prefer a simple, elastic, web-bandage, which may be trusted to do all the work more evenly and better. It upholds the weak joint, and procures absorption both of solid thickening and of effusion. It should be noted, however, that all such appliances aid in producing wasting of the muscles above the joint, of those which move the lower of its segments, and more especially of the extensors.

Dr. Martin, of Boston, Massachusetts, extols his solid, India-rubber bandage, the use of which "alone" or with aspiration, he says is always curative of "synovitis and its sequelæ, in every form and degree of severity, in every variety of diathesis and complication."² By "alone," Dr. Martin means among other things that he does not allow rest of the joint. The observation of the profession at large does not corroborate this experience.

Therefore caution must be exercised, and especially the bandage should not be employed where the limb is much wasted, and it should not be continued longer than necessary. After these various methods have been sufficiently employed, and have had their full effect, the patient may still find considerable difficulty in employing the limb, especially if the inflammation have been severe, and have been in a joint of the lower extremity, whose work is more onerous than that of the upper. To overcome this last remnant of disease is of course a work of time, which may be greatly aided by two procedures—*shampooing* and *passive movement*.

These, more especially the former, are carried out under surgical superintendence by "medical rubbers," the manœuvres being called, in England, "rubbing;" on the Continent, "massage" (kneading); the mere act of rubbing or kneading the part being conjoined with certain movements which the surgeon should so direct that they may affect the most shortened muscles. The rubbing itself should be done with the palm, the ball of the thumb and that of the little finger being chiefly called into play; the direction should be that of the venous circulation, the skin being protected by powdering with flour or starch, or sometimes by inunction with oil; the friction should be energetic, one hand following the other rapidly up the limb; these manœuvres certainly aid in causing absorption of indurations and of thickenings, but I cannot ascribe to them all the somewhat wonderful results that their more enthusiastic advocates claim,³ although there is no doubt that restoration of form may be to a large extent hereby produced. *Passive movement* is one of the most powerful means at our command for overcoming the stiffness so often left after any form of articular inflammation. I shall, hereafter, describe various modes of carrying out the necessary manœuvres, and will, therefore, relegate to a future occasion what must be said on the subject. Here it need only be remarked, that, as simple synovitis rarely leaves behind any considerable muscular shortening, the surgeon has chiefly to do with thickening of periarticular tissues.

¹ Gouty persons are most injuriously affected by lead, and they absorb it into the system with marvellous ease.

² Transactions of the International Medical Congress. London, 1881.

³ The prophet of "massage" is par excellence Dr. v. Mosengeil, to whose papers readers, curious in this matter, may refer (Verhandl. der deutschen Gesellsch. für Chirurg., 4ter Congress, 1875), and he describes a number of slightly differing manœuvres which have, in his opinion, very diverse effects.

The *treatment of dry synovitis* must be conducted on somewhat different principles; the very painful nature of the disease indicates opium, and this drug or its derivatives, alone or in combination, may be freely administered, either by hypodermic injection, or as a remedy by the mouth. Nепenthe is, as I have on more than one occasion observed, a very valuable and efficacious preparation. According to the state of the skin and urine, diaphoretics, diuretics, and alkalis, especially ammonia, may be exhibited, and I believe myself to have found some advantage in colchicum, commencing with a rather full dose, and continuing it in smaller quantities. The food should be sufficient in amount (patients have usually fair appetite), but not stimulating; farinaceous articles, fish, and eggs, are better than meat. It is in most cases desirable to allow a certain amount of alcohol, either as wine, or, better still, in the form of old whiskey, given with an effervescent water. I have twice used the portable-lamp vapor bath; in both cases the skin was very dry and irresponsive to the action of internal diaphoretics, and in both cases benefit resulted, the patients enjoying some hours' tranquil sleep.

The *local treatment* must be conducted on the same lines. Rest on or in a well-fitting splint must be enforced; but also I believe it to be of great importance to keep the skin of the part moist and warm. For this purpose poultices, sprinkled with laudanum; or compresses steeped in liquor opii and water, in equal parts; or, again, equal proportions of glycerine and freshly prepared extract of belladonna, are useful. Ease is obtained in some cases by applying very hot fomentations, fresh and fresh stupes of flannel wrung out of very hot water being constantly alternated, so as to keep the one on the part constantly very hot. Cold and counter-irritants, in these cases, are, in my experience, useless if not injurious.

When the extreme pain which marks the early days of the attack has been somewhat subdued, care must be taken that the joint does not become ankylosed, and, with this object in view, it is well to take the limb from the splint, and very gently to move the part. If pain be produced, such efforts must be postponed to some near future; but movement is often quite or nearly painless, and it should then be continued slowly for a few minutes, when the splint must be replaced, the same manœuvre being repeated at intervals. Rubbing may also be advantageously made use of. When the immediate, acute symptoms are subdued, they are not liable to return under such treatment cautiously applied.

SUPPURATIVE SYNOVITIS.

A joint may inflame and suppurate in various ways; in some instances, and more especially with children, all the structures seem to be simultaneously involved in suppuration. The disease, in such cases, really begins, as we shall see hereafter, in the epiphyseal ends of the bones. Again, pus in the cavity of a joint may originate in pyæmic blood-poisoning, following, for instance, parturition, certain fevers, or urethral irritation. All these cases are to be distinguished from the disease now under consideration, which is entirely local, and which consists in an inflammation, confined at first and for some time to the synovial and perisynovial tissues, running on rapidly to the formation of pus in those parts, and not involving, until subsequently, the harder constituents of the joint.

The most characteristic picture of the disease is usually presented by those examples which follow direct wounds, but equally typical forms may follow other kinds of injury. Histologically, the distinction between *purulent* and *suppurative* synovitis is the greater thickness of tissue involved. In the

former, as we have seen, the mere surface of the membrane, and the parts immediately underlying it, are implicated; in the latter, a considerable portion, or the whole, of the membrane and periarticular tissues are disintegrated, softened, and destroyed, in the manner described by Stricker in the article on the Pathology of Inflammation.¹

I do not purpose here to particularize the minute events of suppurative inflammation, but I must point out what is peculiar to the action on joints. The first perceptible change is redness of the synovial membrane, which, beginning with a slight blush, rapidly deepens into a crimson, and then into a purple hue. It is not uniformly diffused on the surface, but is in blotches of various size and intensity; in some parts, rupture of minute vessels gives rise to chemosis. The redness is not immediately on the surface, but a little beneath a film or fine membrane, which, at first quite transparent, and, as it were, slightly swollen by a serous infiltration, becomes cloudy, then milky in its deeper parts, and, at the same time losing its polish, grows roughened and coarse.² Part of this roughening depends in the earliest stages on increased proliferation of the superficial endothelial cells; another part, on falling away in patches of the endothelial coating; a third, on the over-filled vessels making prominences athwart the basement. At a later period, the roughness becomes more marked and coarser. Some of it appears to arise from fulness of vessels and from thickening of their walls; part of it from a surface condition—from little elevations on the superficies, not unlike a coarse, velvety pile. At this time, and more especially afterwards, it is exceedingly difficult to trace further changes; but if an animal thus affected be killed about a week or ten days after the infliction of the injury—or if, in the human subject, opportunity for anatomical examination be afforded—the following condition is observed: An extremely thick fibrin-containing pus, often blood-stained, adheres to the surface after the usual thinner pus has escaped. A portion of this may be washed away by a gentle stream of water, but some material—whether we call it fibrinous pus or fibrinous exudation—mingled with many leucocytes, adheres so firmly, and is so entangled in the roughness of the surface, that it must be helped away and gently detached with a camel's-hair pencil, or even with forceps.³ When this is accomplished, the inner surface of the synovial membrane is found to be no longer smooth, but to be studded and covered by hypertrophied fringes (Fig. 585), which branch into many ramifications,

Fig. 585.



Suppurative synovitis with fringe proliferation.
(From a specimen in the Museum of the Royal College of Surgeons.)

¹ Vol. I. page 38.

² This account is partly taken from experiments related by M. Richet, partly from certain work of my own in the same direction, which circumstances forbid me further to specify, save to say that the object of my research was to study the phenomena of fringe-hypertrophy.

³ This examination should be carried on under water, a gentle stream flowing into the vessel, and clearing away the opacity caused by the admixture of secretion and débris.

and look almost like a discolored moss, or sometimes like that singular fungus which hangs from the ceilings of old wine cellars. Nor are these beautiful growths confined to those parts of the joint which are normally the seats of fringes; they arise from the whole inner surface of the membrane and hang into the joint, while some, breaking away, float free in the fluid, and, undergoing fatty degeneration and decay, are after a time mere floating flocculi.

The tissues outside the joint, likewise in a state of severe inflammation, undergo the hyperplastic, the indurating, and subsequently the disintegrating processes, so well described by Stricker,¹ which constitute suppuration. These do not, of course, take place equally and simultaneously, save in very severe cases, throughout the whole thickness and extent of the peri-articular structures; hence, we find, after a little time, spots of inflamed tissue ready to break down into abscesses, surrounded by parts still comparatively unaffected. Nor does this apply only to the soft tissues; the bones for a certain distance from the joint become inflamed, but after and more slowly than the other periarticular tissues, and in this inflammation the cartilages of incrustation participate.² If a joint in these stages of disease be removed from the body, and split so as to show in section the interior of the bones, the edges of the cartilages, and those of the synovial membrane and its surroundings, together with the interior of the joint-bag, we find that the latter, instead of being an empty cavity, is occupied by proliferating fringes, looking, as they slightly protrude, like strings of beads or bunches of millet. Outside this, is a district of more or less red, gelatinous material (proliferating areolar and ligamentous tissue). This jelly-like substance, or, as I have called it, granulation-tissue, is traversed by white fibrous cords—that is, by those parts of the capsule which may still remain unchanged, and which are more or less abundant, according to the age of the inflammation. In some parts the new inflammatory growth this evidently breaking down, is perhaps deeply stained by some extravasation; in other parts less metamorphosis has taken place. The section of the bones lays the cancelli and their cavities bare. If the stage of inflammation be still quite early, those spaces will simply be found hyperæmic, and from them some blood-stained serum will exude. At a later period, the exudation will be thicker and yellower; and at one still later, the redness of hyperæmia will be concealed by the creaminess of pus and of exuded fat globules. When this fluid is washed away by a stream of water, one may see that out of each cancellus protrudes a little bunch of inflammatory new growth (due to proliferation of its lining membrane), which before section was compressed within the cavity. After section, the tissue projects so that when the finger is lightly drawn over the surface merely a soft material is felt. If, in going further, this granulation-tissue be removed, we find the cancellar walls variously changed, according to the mode and stage of the inflammation—viz., where the action is more intense and older, their lamellæ are softened by loss of earthy constituents, are thinned by absorption from both sides, or have disappeared. In places where the action is less severe and newer, the indurating phase may be found, the walls being thicker, and the cavities smaller. The softened or disintegrated parts are, unless the action be intense, distributed in spots here and there, and are more or less surrounded by the indurated portions, which, therefore, on section appear as circles, or segments of circles.³

¹ See Vol. I. p. 30 *et seq.*

² Inflammation of cartilage precedes, by periods variable in duration, any breach of substance; a certain change of hue, then dull-white opacity, and subsequently easy impressibility with the finger-nail, and fibrillation, are the macroscopic signs of this condition.

³ More detailed account of these processes (termed *osteosclerosis* and *osteomalacia*) will be given on a subsequent page.

Thus it is to be noted that different phases of pathological conditions exist: 1st. Inflammatory hyperæmia and exudation. 2d. Proliferation and cell infiltration. 3d. Inflammatory induration. 4th. Inflammatory disintegration and formation of pus (tissue-pus, not mere surface secretion). At any point previous to the last, there is still the possibility that retrogression may occur, or be induced, and that the joint may be cured with no or but slight impairment of function; even when the last of the above phases has set in, but before much tissue-destruction has occurred, cure with a certain restriction of movement may often be effected. The restriction depends upon the cicatricial-like healing—the contraction and hardening of previously disintegrated tissue—and its amount therefore is commensurate with the area of the destructive action.

When the bones have suppurated and the cartilages have given way, the cure, if attainable at all, must be by more or less ankylosis, false or true. To explain this, we must return to the onward course of the disease from the point at which we left it—namely, with the joint-cavity full of pus, and with the periarticular tissues occupied by abscesses, or by disintegrated spots ready to break down into abscesses. If the inflammation continue, the altered synovial membrane becomes ruptured or perforated in several places, the pus of the joint-cavity mingles with that of the abscesses in the vicinity, or, being effused into non-suppurating surrounding parts, excites in them pus formation. Both around and in the joint, therefore, destructive action is set up, and abscesses are found in the cavity, in the immediate neighborhood, and, in the worst cases, extending a considerable distance up and down the limb. I am in the habit, in my lectures, of distinguishing these as intra-articular, peri-articular, and adjacent abscesses.

About this time, if not previously, the cartilages become ulcerated, chiefly and most rapidly in the locality of greatest inflammation, that is, in the neighborhood of fringes, which soon mingle with the cellulo-fibrous, cartilaginous débris, in a manner which suggested the erroneous idea, formerly entertained, that the fringes, as it were, eat holes in the cartilage,¹ which was regarded by most authors as an entirely passive and inert material. Instead of, or in combination with, this mode of cartilage destruction, another series of events may occur; for, if the absorption of cancellous lamellæ by coalescing granulations (see preceding page) take place on a rather wide area immediately next to the articular lamella, that plate of bone gives way, and, together with the incrusting cartilage, is pushed by the new tissue into the joint, or rather, in advanced cases, into the confused mass of proliferating fringes and granulation-tissue, which then occupies the joint-cavity. Frequently we find such portions lying detached, or partially detached, with the deep surface rough and gritty, like sand-paper, in consequence of adherence of the disintegrated articular lamella. In either way, the interior of the bone-ends and the area which previously was a joint, coalesce into an inflamed, granulating mass, in which are found the larger or smaller remains of ligaments, capsule, synovial membrane, and cartilage, more or less destroyed by and merged into the new elementary tissue. In the centre is still, in all probability, a cavity partially filled with pus and tissue-débris. This cavity is usually surrounded by others formed by inflammatory disintegration in the substance of the new growth, and these may communicate either with the central space or with the outer air, or with both; they may also extend a considerable distance from the original seat of disease, as just described.

¹ For an account of the inflammatory nature of cartilage-ulceration, see my work on *Diseases of Joints*, 2d ed., p. 339; American ed., p. 269; also, Prof. Stricker's article, in this *Encyclopædia*, Vol. I. p. 38.

While the joint itself is undergoing these transformations, and, indeed, from their early beginning, the neuro-muscular phenomena already mentioned (p. 378) are in great activity, and no longer as merely tonic, but now also as clonic spasms. I pointed out, more than twenty years ago, that the irregular spasms of muscles called "starting pains," coincided and were intimately connected with that hyperæmia of the bone cancelli immediately underlying the articular lamella, which accompanies cartilaginous inflammation. The more potent this blood-fulness, and the more acute the inflammation, the more fully are these spasms, as well as the less irregular muscular contractions, developed. The effect of such forces upon a joint whose ligaments and bone surfaces are altered in the manner above described, is evident, viz., more and more tendency to greater, and even to abnormal flexion, and marked disposition to luxation, or partial luxation, which usually occurs towards the flexor side, but which sometimes is lateral. Their effect on the cartilages, of hastening their ulceration by excessive pressure, has already been mentioned; their influence in keeping up inflammation will be discussed in the next section.¹

Now if curative acts set in, they will proceed by gradual but often pretty rapid fibrillation of the granulation-tissue, which, hardening, squeezes pus from the abscesses, which then become filled with new elements. Yet, as we found that the interior of the bones, and the articular and peri-articular tissues, were all conjoined or matted together by inflammatory products, so when these consolidate and become fibrous tissue of the cicatricial type, it must happen that the parts become all bound together by a kind of ill-formed ligament—that is, are united by *false ankylosis*. If the changes go still further, the fibres become converted into bone—that is, the union is by *true ankylosis*.

On the other hand, if no reparative processes take place at all, suppuration extends further and further, and becomes more and more abundant. It involves not merely the soft parts, but the bones, producing *caries*, or *caries necrotica*, and the pus, passing beyond the spongy portion, invades the medullary canal and medulla. Meanwhile the constitution breaks down, either by way of pyæmia, of hectic, or of lardaceous change. Amputation, when feasible, now becomes the only chance of saving life.

SYMPTOMS OF SUPPURATIVE SYNOVITIS.—Although it is very rare that suppurative follows upon acute, simple synovitis; yet any considerable change occurring during that milder disease, any strongly marked pyrexia, especially if preceded by rigors, should cause us carefully to watch for such a sequence. Ordinarily, the disease now under consideration begins at once with the characteristics of suppuration, but of course the diagnosis is much facilitated, if a wound or indeed any other severe traumatism, has preceded the attack.

Very severe pain in a joint, preceded or accompanied by rigors, a sense of depression and illness, and fever with a high temperature, is rapidly followed by swelling. The kind of *swelling* differs somewhat from that of a simple synovitis; the signs of fluid in the cavity are quite evident, but the surrounding soft parts are also swollen and doughy, and in the worst cases slightly œdematous, and pitting on prolonged pressure. At first noticed merely over

¹ Bonnet, of Lyons, believed that the flexed position was forced upon the limb by the mechanical influence of the distended synovial membrane, and he instituted a number of ingenious experiments which he erroneously imagined proved that contention. The truth is, that joints, when violently inflamed, assume often such positions as greatly diminish the area of the synovial cavity. Moreover, when the cavity has been evacuated by art or by disease, the position is still maintained, or goes on increasing; while, on the other hand, change of posture has marked curative effects which it could not possess, if, the synovial area being diminished, the tension were increased.

the joint, after some time the limb-segment below participates in this œdematous condition. The skin, save over deep joints, is somewhat reddened; not uniformly, but in parts corresponding to the place of the absorbents, or of the larger veins; between these pink parts the skin looks white, and subsequently sodden. If there be an open wound into the joint, it assumes a peculiar look; the orifice from which synovia flowed becomes dry; the granulations, if any have formed, become pale and shrivelled, or if none have arisen, the raw edge of the wound becomes livid and foul.

In from two to five days, according to the violence and rapidity of the disease, contraction of muscles (exaggerated tonicity), causes *malposture*¹ of the joint, which is always towards the side of flexion, and at first is merely a morbid fixity. Very soon, however, clonic spasms, also called "starting pains," are superadded, and with them the position of the limb may become in itself abnormal—flexion may overstep the natural limits, or some subluxation may occur. In the mean time the muscles affected with these spasms waste very rapidly, the limb-segment above the joint more especially shrivelling very quickly. This wasting is often mistaken for additional swelling of the joint, which, lying between two shrivelled parts, naturally appears larger. Measurement will correct this impression.

After a few days the form of the *fever* somewhat changes; it was at first, though high, yet moderately uniform, but it now becomes, sometimes sooner sometimes later, very uneven, the chart marking large variations. In the mean time the tongue becomes furred, and the pulse small and weak.

At this point the surgeon, seeing the patient for the first time, has many difficult points of prognosis to consider, and on them to found his treatment—whether to aim at restoration, or at more or less ankylosis. Unfavorable signs are a more or less œdematous state of the limb below, a dry fufuraceous skin, patchy redness over the joint, with a network of large veins on its surface and meandering up the limb, and progressive aggravation of symptoms, both local and general. Nevertheless, in order to arrive at a sure view, it is desirable to give some anæsthetic, under the influence of which a more complete but a very gentle examination may be made. By palpation, the amount of fluid in, and the distension of, the synovial membrane may be estimated, and the presence and situation of surrounding abscess, as also the presence or absence of bony enlargement, may be determined. Then the joint may be gently moved, while the following points are especially noted: Whether the one bone moves upon the other without crepitus; the presence of that symptom shows of course that ulceration of cartilages has taken place, though its absence does not connote the contrary, since in such ulcers the bone beneath is often protected by granulations. Whether the lower limb-segment moves upon the other in its normal area and sphere. Whether any abnormal mobility be present, as, for instance, a lateral or antero-posterior gliding of the ulna on the humerus, or of the tibia on the femur. A negative to all these queries would go far to induce a favorable prognosis, and strenuous efforts to preserve the joint.

In its further continuance the disease may still remain acute, abscesses

¹ I use this word in a perhaps rather unusual sense; thus, the position of a limb may be in itself abnormal, or, being normal, may be only faulty in its fixity; *e. g.*, a knee bent at a right angle is not faulty as to its position, which is one that healthy knees assume many hundred times in the course of a day; but if that posture be more or less fixed, so that the individual does not or cannot move it out of that angle, this is *malposture* by fixity, even though the surgeon may with very little power alter the angle. To this fixity may, or may not, be added abnormality in the relations of the bones to one another, or flexion may simply be carried beyond the natural limits; here *malposture* by position is added to that by fixity. But when the word "*malposture*" is used alone, I intend to denote either one or the other, or both together; it is a general, abstract term, the more convenient that it does not particularize.

pointing or tending to point in various parts, either immediately over or but a short distance from the joint,¹ and the limb becoming more and more bent; distortion, either from subluxation, or, in young subjects, from diastasis, frequently supervenes, exfoliations may occur, or bare, crumbling bone may be felt with the probe. In some cases fragments of the cartilages come away in the discharges. All through this course of events, the patient's suffering is severe; he eats and sleeps but little, sweats profusely, and emaciates rapidly; the fever, which at first was sthenic, becomes of an asthenic or typhoid character, and, if he still survives, hectic. The fatal issue may be from pyæmia, from exhaustion with lardaceous changes, or sometimes from a rapid form of tuberculosis.

If, on the contrary, the disease be about to improve, one of the earliest signs will be a lower and more even temperature; the pain becomes less, the sweatings cease, the discharge gradually diminishes, the abscesses contract to sinuses, and, the granulations receding from their mouths, these one after another heal, leaving depressed, sometimes greatly depressed, scars, while the abnormal mobility gives place to more and more fixity. If the subject be young, it will be observed, when the joint has healed, that the ends of the bones are smaller than on the other side; not, perhaps, immediately on recovery, but soon after, and at the same period the limb will be found to be shorter than its fellow. After a severe attack of suppurative synovitis, the growth of the epiphyses ceases, as also does the longitudinal growth of the bones from the epiphyseal cartilages adjoining the articulation. This fact must never be overlooked in our prognosis as to the future condition of the patient; it is of course less important in the upper than in the lower limb.

TREATMENT OF SUPPURATIVE SYNOVITIS.—Penetrating wounds of joints are not necessarily followed by suppuration; but they should always be treated with reference to its possible occurrence. I have been till lately in the habit of thoroughly washing, and even injecting, all such wounds with a warm solution of carbolic acid, of the strength of three or four per cent. Of late I have used the boro-glyceride of Professor Barff,² one part in twenty. I have found it better, inasmuch as it is not irritating; one may fill the wound, and the joint itself, with such a solution, without fear of producing any inflammation by the contact of the fluid. At the same time, any dirt or other foreign substance should be carefully removed, and then the limb should be placed on a splint that keeps it at perfect rest. I prefer apparatus which can be removed, since plaster of Paris, starch, or water-glass, may have to be cut away, if inflammation and swelling come on, at a time when every movement of the limb is both exceedingly painful and injurious. The wound should then be covered with several folds of lint or wool, soaked in the boro-glyceride solution, and a simple aperient may be judiciously administered before the patient is left. The treatment, should the joint suppurate, will be the same as in non-traumatic cases.

A brisk, cholagogue purge should, as soon as the premonitory symptoms appear, commence the treatment; then, according to the strength of the patient and the mode of thermometric rise, such remedies as are antipyretic. A large dose of quinine (10 or 20 grains), followed by frequent smaller doses, may be given to the more weakly patients with rapid pyrexial rise; in other cases, the tincture of aconite, from one to three drops, every hour, or every

¹ Acute suppurations come to the surface usually by a pretty direct route; chronic abscesses are more usually turned aside by intervening fasciæ, and, therefore, take circuitous courses and make long tracks.

² For the use of "boro-glyceride in operative surgery," see the *Lancet*, May, 1882, and my paper read at the Warwick Meeting of the British Medical Association, August, 1882.

two hours, will be preferable; again, in others, the citrate or acetate of ammonium. Some form of opiate will be necessary; it is best given hypodermically (morphia), or as a suppository, and may often be combined advantageously with belladonna or atropine. Other drugs, such as digitalis, potassio-tartrate of antimony, or ipecacuanha, may have their applicability in certain cases. Alcohol is often desirable after the first few days, and, if the disease be long-continued, becomes a necessity.

In the *local treatment*, the first consideration is *rest in a good position*; that is to say, if, on his first visit, the surgeon should find the limb in the posture which he would desire, a well-fitting splint should be at once applied; but if a bad position should have already been assumed—and sometimes this takes place very rapidly—an anæsthetic should be given, and the right posture restored. When the disease is still moderately recent, no force will be required; indeed, if placed so that its weight acts advantageously, the limb will of itself assume the desired position. During anæsthesia, the necessary splints should be applied, and, unless the disease be either in the shoulder or hip, the limb should be swung: the upper extremity by means of pulleys and counterpoise; the lower, by the Salter cradle.

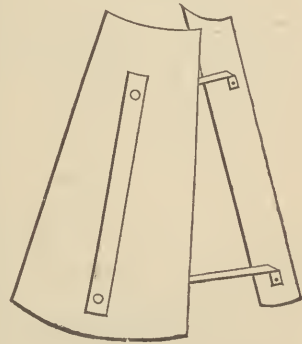
A double object is gained by the restoration of the joint to a proper position: first, the patient's sufferings are markedly diminished, while the violence of the disease is often cut short; secondly, if, in the subsequent course of events, ankylosis is to occur, the limb will be in the posture most available for use. Thus, the shoulder must be so placed that the elbow, a little separated from the side, lies slightly in front of the lateral median line; the elbow must be placed at a right angle; the wrist straight; the knee not quite, but very nearly straight; and the foot so that its long axis is at right angles with that of the leg.¹

When the symptoms show that suppuration is, or is about to be, present, the appliance to be used becomes a matter of very great moment, the simple retention of the limb in a plaster-of-Paris bandage being no longer suitable. The joint must be kept at perfect rest, and yet must be accessible.

The *shoulder* may be bandaged to the side with simply the intervention of a wedge-shaped (Stromeyer) cushion, or, which I prefer, a splint in two parts, both of poro-plastic felt; one part is, for the adult, 9 inches broad at the lower part, 5 inches at the upper, and is to be moulded on the side of the thorax, reaching to the axillary folds; the other, about 4 inches broad, is moulded on the inner side of the arm. When dry, these pieces are removed, and are then joined by riveting through them two brass rods, the higher one so arranged as to keep the upper ends of the splint about one inch asunder, while the length of the lower rod is to be fixed according to the distance at which it may be desired to keep the elbow from the side.

The *elbow* is easily fixed. I prefer a splint made of two metal gutters, the length of the upper arm and forearm respectively, each gutter having projecting at one of its ends a broad tongue of the metal, in which is a hole to receive a clamp-screw for fixation. The portion for the forearm, when cut, is

Fig. 586.



Splint for shoulder.

¹ Diseases of the hip being in certain points peculiar, their consideration is relegated to a subsequent page.

of the shape here given (Fig. 587, *a*). That for the upper arm is broader, and without the hand-piece, but has a similar tongue. When shaped, the splint is formed as at *b*; but the portions must be at right angles with each other. The arm should be swung in a double sling, with counterpoise.

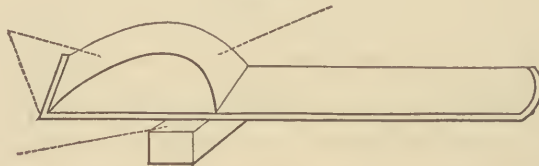
Fig. 587.



Splint for elbow.

The *wrist* may be treated on a simple, straight, or dished, hand-splint; or, better, upon that used for wrist excision, taking care fully to support the fingers and the thumb.

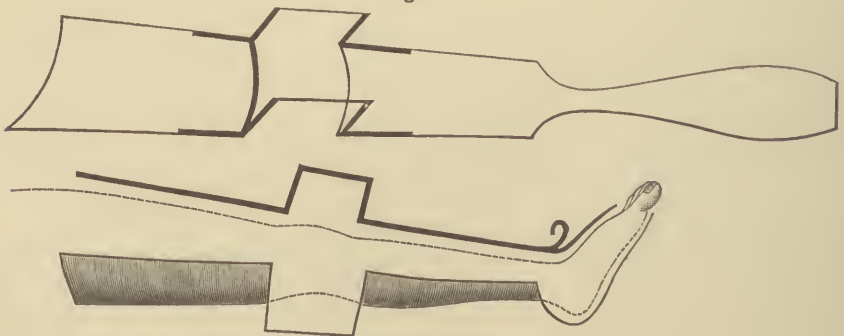
Fig. 588.



Splint for wrist; the hand to rest on the cork addition.

The *knee* may be treated on a MacIntyre splint, properly slung; but useful as this appliance is in simple synovitis, it is not equally commendable in this more serious form of disease, partly because the structure is too hard, partly because the support is insufficient. Of late I have cured two severe cases of suppurative synovitis—the one by ankylosis, but in the other preserving a considerable amount of mobility—by means of the splint which

Fig. 589.



Splint for knee.

some years ago I devised for the after-treatment of knee-joint excision. It consists of two metal gutters, one for the thigh and the other for the leg and foot, fastened together by two steel-wire brackets that stand well away from the back of the joint; with a round, steel rod passing from the groin to the

end of the metatarsus, but bent bracket-wise as it passes over the knee. These splints, being held in position, are secured in their places by plaster-of-Paris bandages, applied with sufficient firmness to the thigh and to the leg and foot, omitting the knee altogether, which thus remains exposed all around for treatment.

Thomas's knee splint is of good construction; but its fault is that it covers all the back and a considerable part of the sides of the joint, which cannot be well got at to make incisions or for other purposes. It consists of two round metal rods united below the sole, or, if small, of one rod bent upon itself so as to make a loop under the foot while the segments run up on the inner and on the outer side of the limb respectively; the inner is a little shorter than the outer branch, so that when they end in an oval metal ring it lies upon them at an angle of 45° , thus fitting the perineum and tuberosity of the ischium, on which it chiefly abuts, as also the groin and outer face of the ilium. Furthermore, there is loosely stretched between these rods a strip or apron of leather, on which the limb is to rest, the apron being slit on either edge in two or three places for the passage of a bandage.¹ Mr. Thomas also advises that in bad cases a couple of wheels connected by a slotted axle should be used; into the slot the loop of metal under the foot is to be inserted to keep the back of the limb from the bed; but it is far better to sling the whole apparatus.

Fig. 590.



Thomas's splint for the knee in the recumbent position.

The inventor claims for this that it perfectly and entirely immobilizes the joint—an assertion which my experience leads me very much to doubt; there is always a certain play between the edge of the apron, to which the limb is attached, and the irons. Moreover, the irons themselves are too much in the way of the surgeon, the joint having to be treated while lying in a sort of ditch. A great part of these objections might be overcome by bending out, bracket-wise, the two irons, opposite to the knee, and making the leather apron in two parts, one for the thigh and one for the leg, omitting the part behind the knee altogether.

The *ankle-joint* may be fixed in sundry ways. In severe cases, the lower part of the splint for the knee (Fig. 589), with a plaster-of-Paris casing, omitting the joint itself, is the steadiest and most secure. But a simpler splint may be made by moulding to the leg and foot, including the sole, a piece of poro-plastic felt. This must more than half encircle the leg, and must take in all the heel, the side, and the sole of the foot, as far as the root of the toe (inner or outer). If greater security be thought desirable, such an appliance may be made in two portions, one for the inner and one for the outer side of the limb. When dry, the felt is to be removed, and a couple of interrupting brackets (previously prepared) riveted so as to stride over the ankle; the part of the splint included in the gap of the brackets can then be cut away. The limb should always be slung by a Salter's cradle.

Whatever form of splint be preferred, I would point out that, in this disease, entire immobility is one of the great essentials, while the other, perhaps hardly less important, is accessibility to almost all the joint surface, per-

¹ Thomas, On the Treatment of Hip, Knee, and Ankle-Joint Disease.

mitting, if necessary, thorough examination day by day; otherwise, accumulations of pus may very easily escape notice, or, if perchance found, can hardly be treated save by removing the splint, which is a painful and injurious process. The apparatus should be at once prepared, and as early as possible applied, when symptoms threatening suppuration have been recognized; but if it be evident that pus has not yet formed, its production may sometimes be checked by using a strong revulsive, such as a very strong tincture of iodine (60 or 80 grains to the ounce of absolute alcohol), or the actual cautery. The resulting inconvenience, if this does not effect the desired object, causes me to recommend the method only in exceptional cases. A sharp degree of cold, amounting almost to congelation, is more advisable; it may be obtained by either a bladder or bag containing powdered ice, alone, or mixed with a little salt. The mere momentary application of such a remedy is valueless; it must be maintained for a considerable time. Should we, on the contrary, find the joint fluctuating and tense, and yet be led to judge, by the character of the pain and by the amount of pyrexia, that the fluid is possibly not pus, subcutaneous incision (page 388) will give great relief, and is that treatment which is most likely to result in cure. Nor, even if the fluctuation be produced by pus, need we fear the effect of letting this liquid lie in the periarticular tissue: if the disease recede, it will be absorbed; if it continue, an abscess outside is preferable to one inside the synovial sac.

But it must be understood that in the last sentence I refer to cases not yet fully developed—to cases in which it may still be doubtful if pus have as yet formed. When, on the other hand, all the symptoms point to acute abscess within the joint cavity, if it be increasing and the surface veins strongly marked, more vigorous measures are safer. Incisions into the joint should at once be made,¹ so freely as to give unobstructed exit to the pus; this ought to be done in such a manner as to prevent putrefaction. For some months I have given up carbolic acid and the spray, the complicated dressings, etc., of Prof. Lister's method, and have found that abundant syringing of the cavity with a 5-per-cent. solution of boroglyceride, and dressing with the same, is safer, and quite as efficacious. The choice of place for the incision or incisions may safely be left to the anatomical knowledge of the reader, and it must also be guided by observing the point of greatest fulness, and also by the position of the joint, for the opening should be as low as possible, so as to permit of the best drainage attainable.

Having secured these great essentials of treatment, good position, entire rest, with support and thorough drainage, the rest of the treatment closely resembles that of any other deep abscess. The cavity must be syringed or irrigated, day by day, with a cleansing and antiseptic solution, and great care should be taken that the drainage tubes are free and pervious; also, the joint must frequently be examined lest any fresh abscess form and, unsuspectedly accumulating, burrow up the limb. Especially careful must be the search, of course without disturbance or motion of the part, should the thermometer rise again. If the pus have been fully evacuated by the first incision into the cavity, the thermometer will fall from 102° or 104° to only a little above normal. If at any time it rise, not suddenly, but gradually for several days, there is in all probability retention of pus, which must be let out, even though it lie extremely deep. If the thermometer remain steady between 98° and 100°, pus is not likely to be forming afresh, but in all probability the joint is going through the various healing processes favorably and well; that is to say, the part which has suppurated, be it larger or smaller, or be it the whole joint, is getting repaired by the act of granulation, during which the surgeon must

¹ This treatment had fallen into disuse since the times of its early advocates, Petit and afterwards Boyer; it was revived by Mr. Gay. (*Med. Times and Gazette*, vol. xxiv. p. 546.)

watch for fragments of cartilages which may be shed, and, coming forward towards the abscess-opening, may obstruct, until extracted, the due outflow of pus. Thus he must guide the patient through the dangers inseparable from deep abscess close to and between bones; he must watch the behavior of the pus, guard against the tendency to burrow, especially upward, along and close to the bone; especially must he watch the general condition of the patient in the first part of the case, considering the danger of pyæmia. Afterwards, and when the suppuration has gone on for a lengthened period, hectic, and especially the evidence of lardaceous disease, must be looked for. Amputation will sometimes be the only means of saving life.

But when these dangers do not arise, or having arisen have been successfully combated, the local processes will duly complete themselves; the pyogenic and granulation tissues will have become consolidated into a fibrous mass, a sort of cicatricial tissue. The surgeon may now by his treatment conduce to the ankylosis becoming true, or he may keep it false. As a rule, it is better, in the upper extremity, to aim at the latter event, by the use of passive motion more or less vigorously applied according to circumstances. At the hip (in which joint suppurative synovitis is a very rare and very fatal disease), any slight mobility is a great boon, but is difficult of attainment. At the knee, much depends upon the following circumstance: If there have been abnormal mobility, especially lateral mobility, it is best to permit true ankylosis, lest a loose or flail-like joint result. Slight mobility at the ankle is desirable, but the bones of the tarsus acquire such considerable mobility among themselves, as greatly compensates for an entirely stiff ankle should true ankylosis occur.

SYNOVITIS FROM ABSORPTION OF MORBID MATTERS.

The above forms of synovitis, viz., simple, sanguinolent, purulent, dry, and suppurative, are the only acute, inflammatory diseases, purely local in origin, of the synovial membrane. But a large number of joint-diseases are due to absorption into the blood of poisons, in all probability of different sorts of pus.¹ Other forms of joint-malady are merely local manifestations of diatheses—rheumatism and gout—while one synovitis of subacute form is ascribable to an acquired taint, viz., the syphilitic.

These various forms must be studied, and we will take them in order, as above. Diseases which produce synovitis by absorption are very many, and may be arranged as those: (1) Following or accompanying wounds or childbirth; (2) following or accompanying gonorrhœa or the use of bougies, etc.; (3) following or accompanying pregnancy and certain disturbances of the menstrual function; and (4) following or accompanying the exanthemata and dysentery. The first of these divisions includes all those forms of pyæmia in which articular manifestations occur. The etiology and symptoms of pyæmia have been already given in this work,² and it will be gathered from the article on that subject, that the disease is very variable, and may occur under widely different circumstances; and so also we find variety in the modes of local manifestation, variety in the places where secondary deposits take place, and variety in the appearance of the affected joints and of the tissues immediately next the deposit. As a very general rule, several joints are affected, some only in a transient manner for thirty-six or forty-eight hours, others more persistently. When after death the parts are examined, it is found that the

¹ In some of these cases the pus is putrid or putrescent, in others it contains a virus due to certain fevers or exanthemata.

² Vol. I. p. 203 *et seq.*

chief deposition has occurred either within the joint cavity or in the surrounding parts—especially in the tendinous sheaths¹—rarely simultaneously in both places. If the joint cavity be the seat of deposition, the periarticular tissues and neighboring sheaths are more wet than usual with a serum that is generally a little turbid. When the secondary deposit is outside the joint, there is hardly more than the ordinary amount of synovia within that cavity, nor have I, as a rule, found it changed in quality; sometimes it is inspissated like the fluid of ganglia, but quite bright; sometimes it is rather large in amount, rarely muddy.

The pus of the secondary abscess is often in its macroscopic characters quite normal; it may, however, be already separated into turbid serum and sodden flocculi, or it may be thick and of a brownish color, sometimes uniformly, sometimes in streaks or blotches. The microscope shows that even in the apparently “laudable” samples the corpuscles are irregular and broken down, and this is still more the case in the abnormal varieties. Very frequently the fluid has a faint sweet smell, a slight exaggeration of the pyæmic breath-odor; not unfrequently the taint is more decided, recalling the odor of putrefaction—or is exactly that detected during life in the patient’s wound or discharges.

Occasionally, the tissues which are the seat of the deposit are a little pinker than usual, especially if the disease be of some standing. The pink coloration is seen in little scattered spots; these are usually, and this especially refers to the synovial linings of joints or sheaths, a little yellow, and are here and there softer and more fragile than in the normal state, their endothelial lining being sodden and loose. In the great majority of cases, and until the pus has been for some days in the part, there is no sign of inflammation, or, more strictly speaking, of inflammatory phenomena, such as hyperæmia, thickening, etc.

From this it must be concluded that the pus is not produced by inflammation of the tissues among which it is deposited; the contrary sequence of events may, however, occur, viz., that the pus deposit, after a time, provokes inflammation in its immediate neighborhood.² Nor must we, on the other hand, suppose that the materies morbi is taken up bodily from one part and deposited in that form in another; it appears rather that by certain matters (living or chemical contagium) received into the blood, that fluid is so changed that it consists chiefly of altered leucocytes and a not perfectly healthy serum; that these leucocytes have a great tendency to aggregate, hence to fall to the sides of the vessel, therefore to emigrate; that in this single act the process resembles one act of inflammation, but that the other factors of that state, viz., the condition of the blood, that of the vascular walls, and that of the tissues, are either absent or entirely different.

✓ SYMPTOMS OF SYNOVITIS BY ABSORPTION.—The general symptoms of the pyæmic state do not concern us here; it need only be said that after a certain duration of characteristic pyrexia and exhaustion, the patient complains of pain in one or more joints, or may simply, without complaint, cease to move a certain limb. On examination, the joint or joints will be found swollen, and, save in exceptional cases, other articulations will in a few days be similarly

¹ This is more especially to be observed in such joints as the wrist or ankle, which are crossed by many tendons in synovial-lined sheaths.

² I would call attention to the fact that, after death from severe but not too rapid pyæmia, the vessels of transparent tissues, for instance, those of certain parts of the peritoneum, of the lung-surface just beneath the pleura, and more especially of the pia mater, will be found in many areas, and through certain lengths of their course, to contain a yellowish fluid like very thin pus, amid which a central streak or dots of red will be found.

affected. The swelling is not like that of simple synovitis. Even when the joint-cavity is manifestly full of fluid, considerable periarticular effusion, sometimes evidently situated in tendinous sheaths, masks the shape of that membrane in distension. The skin is in nearly all cases white. If redness be present at all, it is of a pink quality, in lines, and in the site of lymphatics. A network of large veins is commonly very distinct, and this appearance is usually combined with œdema of the limb below. The temperature of the body is in this disease very high, but I have never been able to find any local elevation about an affected joint.

Metastasis from joint to joint is in the early stages common; in the latter—that is, when the local disease has lasted six days—it is rare. In certain of the more chronic forms of blood-poisoning, and especially in such as will now come under consideration, the patient complains of pain in several joints, as the shoulders, sterno-clavicular joints, wrists, knees, etc. Examination reveals no swelling, but there is usually some tenderness. After a few days, most of these pains disappear, and localize themselves in one or two articulations, which then assume the characteristic appearances. It is these vague, multiple joint-pains which cause some of these maladies to be so often mistaken for rheumatism.

If we keep before our minds a case of acute pyæmia from wound or from parturition, there would seem no possibility of confounding the disease with acute rheumatism; but, as before said, these are not the only forms of blood-poisoning with which we have to do; indeed, one of the diseases ascribable to this cause has, since the appearance of my writings on this subject, almost ceased to be called by its former name of “gonorrhœal rheumatism.” I would name it instead, “urethral synovitis.” It very commonly follows upon long-standing, or inveterate, or neglected gonorrhœas, and especially when the inflammation has passed far back; but it is occasionally produced by the use of bougies, etc. It usually begins with a rigor, and a rise of temperature up to 100 or 102° F., very rarely higher. After this, the patient, feeling very ill and depressed, complains of pains in several joints, among which is nearly always the knee. Ultimately one, or at most two joints remain affected. Sometimes a rather mild but obstinate conjunctivitis, rarely iritis, is also present.

After from five to nine days, the most severe stage of the disease subsides, and the temperature is rarely above 100° F.; but the joint, though but slightly painful while at rest, is very tender on pressure, and cannot brook any movement. This subacute stage is exceedingly obstinate, and at any time while the gonorrhœa lasts, even though it be a mere gleet, relapse may occur. If the patient, too, after being cured, contract a fresh gonorrhœa, he will, though years may have intervened, be almost certain to have recurrence of the articular disease.¹

The existence of joint-affections connected with the female genital system was unsuspected by surgeons until a comparatively recent date, because they were always taken for rheumatism; nevertheless, there is no doubt but that such exist; and since the publication of my work I have received many confirmatory communications from other observers. Some of these affections are connected with the pregnant or parturient state, others simply with disturbance of the menstrual function. The former we may describe as “ante-partum” and “post-partum.” Occasionally there seems to be a link of connection between the two varieties. Ante-partum joint-affections occur mostly about the fourth month of pregnancy, and, judging from what I have

¹ For examples, see Volkmann, *Krankheiten der Bewegungsorgane*; Pitha und Billroth, *Handbuch der Chirurgie*, Bd. ii. S. 505. See also my work on *Diseases of Joints*, 2d ed. p. 113.

seen, are most common in women who, when not pregnant, suffer from leucorrhœa. Rigors are often absent, but pyrexia is always present, together with malaise and inertia—in short, the prodromata of a feverish attack, together with vague pains in the back and limbs. The fever, after about a week, subsides; the pains gradually become less general, and fix themselves, after wandering in a vague and capricious manner, in one or perhaps in two joints. When arrived at the uniarticular stage, the knee or the hip is the favorite joint.

In most cases this malady subsides in from ten to twenty days, and the patient is thought to have passed through a subacute attack of rheumatism. But sometimes abortion intervenes, after which the recovery is more slow, the movements of the joint being difficult to re-establish; in some cases complete ankylosis ensues. A rarer form is very severe, even fatal; if, after six or seven days from the first attack, the fever does not decline, but, after irregular rigors, increases, the symptoms assume rather the form of traumatic pyæmia, and the affected joints become more swollen, fluctuate, and are evidently filled with pus. If in this typhoid state abortion takes place, death rapidly supervenes.

A similar but milder form occurring between the middle of the third and the sixth week after childbirth, is very unusual, unless it have been preceded by ante-partum synovitis. It usually begins in the shoulders, elbows, and wrists, yet generally migrates to the lower extremity. The pyrexia is not great, and the local affections are chiefly periarticular. The patient usually recovers without permanent damage to any joint.¹

The synovitis connected with irregularity or with accidental suppression of the catamenia is sometimes a mild, at other times a severe disease. I have known it to occur in matrons who had borne many children, and in the unmarried. It is most apt to attack women of lax fibre, who suffer from leucorrhœa, and who during a menstrual period are exposed to cold, producing suppression of the flow. A feverish attack follows, often preceded by rigors, and accompanied by pains in several joints, which are usually ascribed to rheumatism, and which, after a few days, concentrate themselves in one joint (rarely in two), most generally the knee or hip.² The characteristic local conditions of all this class of cases are well marked, viz., that the swelling is largely periarticular, and that after the first few days pain, while the joint is at rest, is almost absent, but is very severe on contact or movement.

We now turn to another set of similar, but not identical, joint-affections, which arise during the course or after the subsidence of certain fevers—viz., enteric fever, smallpox, scarlatina, diphtheria, measles, and mumps—and also of dysentery. This class of joint-diseases deserves a closer study than has yet been accorded it, but a difficulty lies in the apparent rarity of these affections, which almost precludes the possibility of any one practitioner seeing a sufficiently large number of cases. Yet it may well be that when attention is called to the subject, these conditions may be found more common than they are at present supposed to be. For instance, we often hear of a “rheumatism consecutive to scarlatina;” less often of one “consecutive to measles;” but a better appreciation of these multiple joint-pains, which have been thus likened to rheumatism, would insure a clearer insight into their nature, and a better starting-point for their study.

In the first place, I would point out that of most of these diseases, suppurations, broken surfaces, or ulceration, is an integral part; and that, therefore, there is a clear point of inter-relation between them and the possible absorp-

¹ In one out of the only four cases that I have seen, a false ankylosis of the elbow took place.

² In the two most severe cases that I have seen, the knee was attacked in one, the hip in the other; in both cases false ankylosis resulted.

tion of morbid matters, while there is no evident connection between these maladies and subacute rheumatism. Moreover, the supposed "consecutive rheumatism" has never the slightest tendency to induce pericarditis or endocarditis.

The joint-disease of *typhoid fever* is peculiar, as having a marked tendency to attack the hip and to produce rapid dislocation. I have seen three cases of this kind, and my colleague, Mr. Bellamy, had another case under his care, in which suppuration of the left hip occurred during the course of typhoid fever. In the three cases which I saw, the dislocation occurred, in one, during an unknown period of the fever; in two, some time during the third week. In two cases the patients were very apathetic and comatose, and did not complain of pain; in one of them the dislocation was only discovered as the patient began to convalesce. In one of the three cases the patient suffered much at the hip during three days, when the pain almost suddenly ceased; probably this cessation was due to the dislocation, and consequent relief of tension. In none of the cases could the bone be replaced. There is occasionally, too, during typhoid fever, a multiple form of synovitis, of which I have seen but two examples. *Mumps* is, as is well known, subject to singular metastases—sometimes to the testicle, less usually to the brain, still less commonly to one or more joints; it rarely passes to more than two articulations, and more often is confined to one. When the two former changes of place occur, the parotid ceases, as a rule, to be inflamed; but the disease may leave the part secondarily attacked, and return to its first locality. When a joint or two joints become affected, the parotitis continues; nor does the joint-disease exhibit sudden shifting of place. It is characterized by rapid effusion into the synovial membrane, and by severe pain. I believe this condition to be brought about by impregnation of the blood with inflammatory products.

Exanthematous synovitis may be either a mild or a very severe affection; it is multarticular, and in its milder manifestations is so very like acute rheumatism as to be generally mistaken for that disease; in its severer forms it not only leads to local lesions, but comports itself like ordinary traumatic or puerperal pyæmia; *scarlatina* is that exanthem which is most often followed by these manifestations, especially in the more violent forms; *measles* that which leaves the most persistent, chronic sequelæ, after passing through the usual acute stage. I cannot see any generic difference between the milder and the severer form; the amount of poison absorbed, or the condition of the poison at the time, causes a difference in the amount of local and constitutional evil produced. There is also a peculiar joint-disease, consecutive to, rather than a cotemporary of, the exanthemata, more especially *scarlatina* and *diphtheria*; it is uniarticular, and attacks the larger, never, as far as I know, the smaller joints; it is marked by very rapid and considerable, but painless, effusion, and occasionally by dislocation; it attacks, in preference, the shoulder, hip, and elbow. Synovitis has been observed after *dysentery*, more especially after epidemic dysentery; the disease begins with the commencement of convalescence, never attacks any joint but the knee, and is marked by considerable effusion.¹ It is a rare disease. *Measles* is followed rather than accompanied by a later and a slower form of synovitis, extremely apt to become quite chronic, and to degenerate into the ordinary form of strumous synovitis. All who have had much experience in the maladies of childhood, must have noticed how frequently the commencement of scrofulous disease of the cervical glands, of the viscera, or of the joints, tallies in point of time with the convalescence from measles.

¹ See Braun, Schmidt's Jahrbüch. Bd. xviii. S. 202; and Witowsky, Prager Vierteljahrsschr. 1847.

One point which I have left to the last, but which is of much importance pathologically and practically, is the singular fact that all these joint-affections which occur in connection with fevers, are in certain epidemics comparatively frequent, in others extremely rare. There is at present no clue to the interpretation of this peculiarity, nor will any be found until the conditions of bodily temperature, dates of eruption, periods of convalescence, atmospheric conditions, etc., in such epidemics, are carefully noted and compared. The knowledge of the fact cannot, however, be otherwise than useful to the practitioner who encounters one such event, in his interpretation of succeeding ones.

TREATMENT OF SYNOVITIS FROM ABSORPTION.—Since the joint-affections of pyæmia, whether from wound or parturition, are but local accidents of a systemic condition, the topical management of the articulations can be merely ancillary to the general treatment of pyæmia. I am very far from considering that pyæmia is a hopeless condition, as if the patient had received an irremovable dose of some necessarily fatal poison. On the contrary, if the clinical histories and the temperature charts of a number of cases be studied, the opposite conclusion is almost inevitable. We find in the beginning a rigor, or succession of rigors, followed by a rise of temperature; after a certain number of hours the thermometer falls, then follows another rigor, and another period of pyrexia, and so on alternately. In cases in which the contagium is not very powerful, or in which the patient is of a strong constitution, the intervals between the fits of rigors are fairly prolonged, and the temperature becomes almost normal before each succeeding attack. Where the opposite conditions obtain, the rigors succeed each other very rapidly, and the thermometer never sinks much. In the worst cases, the initial shivering fit is followed by a pyrexia which never much abates, and if rigors recur, they are ill-developed or abortive. The first of these clinical conditions evidences an alternate absorption and elimination of a morbid material—a poisoning by reiterated doses; the second, a like series of events, but, the dose being either stronger or more rapidly absorbed, is not so fully excreted previous to the reception of a fresh instalment. In the third set of cases, the poisoning is more potent and continuous. Hence it is to be concluded that the system has great power of getting rid of the contagium, but that it may succumb to persistent poisoning, either continuous or remittent.

These considerations suggest two methods of treatment: (1) to aid the elimination or destruction of the poison already absorbed, and so to fortify the system that it may carry out these processes to a successful issue; (2) to annul or weaken the local source where the poison is formed and whence it is absorbed. These two must in most cases be combined. In puerperal pyæmia, the source of poisoning is some sepsis within the genital tract, and there is no doubt that, if either by plentiful aseptic irrigations, or by removal of putrefying placenta and clots, or more certainly by both means combined, the source of putrefactive poison can be destroyed, the patient who has not already absorbed too much, may be saved.¹

A wound which has got into such a state as to set up systemic poisoning, must be treated on the same principles, the mechanism being modified to suit the situation of the poison. Thus, it should be opened up so as to expose all its depths and crevices as completely as possible, and these must all be thoroughly washed and purified with carbolic acid, boro-glyceride, or some

¹ In my work on joint-diseases, a striking example of this mode of treatment is recorded; and Dr. Matthews Duncan has published very similar cases.

other antiseptic. But since the tissues around the wound certainly contain, and will, if left uncared for, generate, fresh contagium, some means of annulling or minimizing this production must be used. I have found the best method to be by interstitial injection, using for this purpose a tubular needle, perforated not only at the end, but in several points at the sides; the collar of the needle either fits a syringe holding about an ounce, or by means of an India-rubber tube may be connected with a glass one of $\frac{1}{4}$ or $\frac{3}{8}$ inch diameter.¹ The needle is introduced into those parts where lividity is present, where veins are enlarged, or in the course of veins, and by predilection above the wound, and is moved somewhat while the fluid flows; from one to three fluidrachms of a 3-per-cent. solution of carbolic acid may be safely injected. While this treatment is being conducted, a portion of the urine from each micturition should be put aside to be examined before another injection is made; if the urine does not assume the inky appearance due to carbolic-acid poisoning, the dose may be repeated, and, when desirable, even increased.²

On each occasion, care must be taken not to let all the fluid used accumulate at any one point, but to spread it over a certain district; and on each repetition of the injection, a fresh part must be chosen until the vicinity of the wound is exhausted, and then the series may recommence.

In the mean time, the temperature must be reduced by the administration of suitable remedies. If the skin be dry and hot, an effervescent solution of citrate of ammonium is very valuable.³ It may be given every three or four hours for one or two days and nights, or until the skin becomes moist. Afterwards, or even at the beginning, if the surface is not at the commencement markedly dry, we may administer large doses of quinine. In giving the drug for this purpose, it is better not to temporize, in view of the grave condition with which we have to deal; a little headache or temporary deafness is unimportant, and I would therefore recommend 20 grs. given in one dose, to be followed by a like amount in two hours, or if the case be severe in one hour; and then, if the temperature fall, after an equal interval by 10 or 5 grs., according to the effect produced; at the same time, a stimulant—brandy, champagne (especially if there be sickness), or sherry—may be properly administered. If no parenchymatous injections of carbolic acid be used, perhaps even when their employment produces no sign of poisoning, another drug may be administered by the mouth—and I believe myself to have seen it productive of benefit—namely, the sulpho-carbolate of sodium, in scruple doses. There is no doubt, as shown by the odor of the breath and the occasional discoloration of the urine, that this drug becomes absorbed into the blood, and must in so far render that fluid unfavorable to the life of septic fungi.

In the general treatment of less acute forms of this malady, such as urethral or catamenial synovitis, less drastic remedies are necessary. I may be permitted to say, that the analogies with the rigors occasionally following catheterization, are not to be ignored. Those shiverings are successfully treated in one of two ways: We may either immediately give one or two large doses of quinine; or we may administer a glass of very hot spirit and water, cover

¹ The length of a column of fluid, an ounce in quantity, contained in such a tube, insures considerable pressure on the liquid in the needle.

² Since introducing boro-glyceride as a surgical dressing (see *Lancet*, May 13, and *Brit. Med. Journal*, Aug. 26, 1882), I have had no opportunity of testing its value in pyæmia, but as it is a powerful aseptic it would probably be followed by good results. As it is not a poison, more entire and wide-spread saturation of the tissues would be possible, than with carbolic acid; but powerful as boro-glyceride is in preventing sepsis, it is not, I think, as potent as carbolic acid in counteracting a putrefactive action already set up.

³ Made by mixing solutions of 25 grains of carbonate of ammonium in a fluidounce of water, and 20 grains of citric acid also in a fluidounce of water.

the patient warmly with blankets, and cause him freely to perspire. It is probable that were a surgeon called, upon the first manifestation of the other forms above named, one of these methods might cause the attack to abort; at all events, my observations go to prove that considerable sweating will both shorten exanthematous synovitis and relieve the pain.

Purgation, in all these cases, should only be employed when the alvine condition necessitates its use, or when the excretions are particularly foul. It is true that a certain amount of elimination may be effected, but we must remember that absorption will at the same time be stimulated.

Thus much for the general management; as for the local treatment, it must, in severe cases and while the danger is very imminent, be limited almost entirely to the use of some light support; such patients lie sometimes apathetic, and perfectly still, but at other times there is much jactitation. Under these circumstances, to apply any strict restraint would be imprudent; to maintain it, usually impossible. The arm may, however, be bandaged to the side, a pad or cushion being interposed, when the shoulder is affected; when the hip is attacked, the use of weight-extension is the best treatment, since, while restraining, it yet yields to movement. For like reasons, in disease of elbow or wrist, or knee or ankle, the limb should be placed in some light splint and sling. Besides these mechanical means, it may be desirable, when the genital passages or the neighborhood of the wound have been cleansed by irrigation or injection, to apply the latter mode of treatment to the periarticular tissues also.

But, when the urgent pyrexia is past, the joint-affections often become very lingering; indeed, some of them, as, for instance, the urethral and catamenial varieties, usually assume that character from the first, while other forms often exhibit a tendency to run into suppuration, or to terminate in rapid ankylosis; this is especially the case after scarlatina. Hence, in all these cases retentive apparatus is desirable. At first, and while any heat is present, or while the points of special tenderness are impatient of pressure, those appliances which keep the joint at complete rest should be used; afterwards, and particularly in those maladies which most tend to ankylosis, the forms of splint which prevent pressure, while permitting a certain amount of movement, are preferable. In protracted cases, where a certain low form of fever continues for a lengthened period—when the bodily powers have been so weakened that we cannot much move the limb, or the patient, without danger—one of those forms of splint which facilitate the retention of the limb in various positions should be employed. In such an apparatus, the limb can be kept in perfect quietude at an angle which is changed every twenty-four or forty-eight hours, so as to prevent true ankylosis, and so as to cause the bands of a false ankylosis to be as lax as possible.

STRUMOUS SYNOVITIS.

Struma is a state of the body which is usually inherited; it is not a disease, but a condition which renders many of the tissues (lymphatic, connective, epithelial and endothelial) very prone to respond to slight sources of irritation, by prolonged inflammations tending to suppuration and caseation. A child who is strumous, although bearing certain characteristics that mark the constitution, may for years, perhaps altogether, escape disease, but if some excitation, traumatic or otherwise, arises, the resultant malady will present the diathetic type. Now the marks above referred to are produced by certain characteristics in the nutrition and growth of the connective, lymphatic, endothelial, and epithelial tissues. They are of two varieties:

the one, in which a considerable tendency to growth is combined with incompleteness or at least tardiness in completing the process; the other, in which the finish of the modelling is perfect, even exquisite, but in which the nutrition or assimilation by the tissues is insufficient. The former of these types is marked by a want of definition about the making of the features; we might say, if we were speaking of a sculptor's work, that a rough lump-sketch had been blocked out, but that the outlines had been left blurred, and that the modelling was unfinished. Thus the head is large and uneven, big behind; the ears are large and stand out widely, their folds and edges being thick and badly marked; the undecided, thick, under lip is apt to droop, and both it and the upper one to crack; the alæ of the nose look swollen and have no distinct edging, nor do they come off from the face at a well-defined place, unless marked by redness round about. The eyelids also, often edged with red, and fringed with short, thick lashes that stand out in different directions and are apt to mat together, have the same lack of clear and distinct modelling; add to this a dull, coarse hair, gravel-colored or lustreless black, and we have the strongly drawn type of that struma which tends to the scrofulous, the glandular-swelling variety. The characteristics of the other kind are much more pleasing, indeed often exquisitely beautiful: the thin skin, almost translucent in its delicacy, either of the milk-and-rose or of the soft-brunette complexion, covers features of the finest form and most refined modelling; the long eyelashes fringe their lids marked with a delicate tracery of wandering veins; the eyebrows are softly pencilled; the forehead is placid and smooth, with ash-gray tones in the half shadows; the long hair is delicate, fine and silken in texture; and the lips are red and finely cut. There is no particular complexion for this form; the hair varies from brown, through auburn, to very fair.¹ Often a fine but long down grows on parts not usually hairy, especially at the edges of the usual capillary growth—for instance, low and far forward on the temples and sides of the forehead. This type tends little to scrofulosis, but rather to tuberculosis.

Both these types of personal formation are the result of certain peculiarities of nutrition, affecting the areolar and other connective tissues; and since inflammation is but a modification of nutritive acts, it is evident that if nutrition be peculiar its modification will also be of a peculiar type. We find therefore that inflammations occurring in strumous persons—or, if we like to call them so, “strumous inflammations”—are marked by certain special features, viz., a tendency to fall into a very chronic form, and for the inflammatory products to remain during lengthened periods embryonic (granulation-tissue), and then either to caseate or to suppurate with much fatty degeneration. Indeed, according to Billroth,² “we may assume a scrofulous diathesis for those cases in which a slight and transient irritation of some part of the body sets up a chronic inflammatory process, which not only outlasts the irritation, but spreads or continues independently of it, and which usually results in suppuration or caseation, and rarely assumes the form of pure hyperplasia.”

In the British Islands, and more especially in the large towns, struma is very prevalent; hence we have to do, in both hospital and private practice, with a great number of inflammations which have the characteristics given by Billroth very strongly marked; among these is a class of very chronic and very persistent joint-diseases, having but little tendency to get well, but apt rather to run on to destructive processes. The history of such cases may be conveniently described as passing through three stages.

¹ The combination of very dark hair with blue eyes is significant.

² Scrophulosis und Tuberkulosis; Pitha und Billroth, Handbuch der Chirurgie, Bd. i. Abth. 2, Heft 1, S. 311.

FIRST STAGE.—A child, generally under eight years, who may or may not have had an attack of measles¹ or scarlatina, or who may have suffered from enlarged cervical glands while cutting the back teeth, or who may hitherto have been perfectly healthy, is observed sometimes, without any sign of pain, to have a swollen joint. In some cases this is preceded by a slight injury, in others the evidence of traumatism is conjectural, and again in others the absence of any violence is distinctly affirmed; often, and these cases are in the end the worst, there is no evidence of pain.

The enlargement slowly increases, and soon the child limps, if the lower limb be the seat of disease. When examined, the swelling is seen to be of a very shapeless, indefinite character—rounded, but not marked by the ligaments, etc., as in acute synovitis; its consistence is semi-clastic, and in this stage equally resistant throughout, concealing both to sight and touch the form and markings of the bones and other anatomical points. The joint is easily movable within certain restricted limits, and the motion, unless these limits be overstepped, is painless, as is also moderate pressure. The color of the skin up to this point is either unaffected, or it is rather white.

The opportunity of examining joints, even in this very early stage, sometimes fortuitously occurs; we find then that the cavity contains a slight excess of fluid, which usually is turbid from the admixture of many cells, some of which are like leucocytes, but most of which are derived from the endothelial lining of the synovial membrane. The inner surface of that structure is no longer smooth and polished, but is studded with little rounded or pyramidal elevations, and presents, not the branched and dendritic growths of suppurative synovitis, but a different form of fringe, hypertrophied into thin,

vascular membranes, which encroach upon and overlies the cartilages. They are at first quite fine and delicate, digitated or foliaceous, and fenestrated here and there, where in their luxuriant growth two or more of the digits have coalesced at their extremities, leaving an unoccupied space between. Very soon these pannus-like formations increase in thickness, become coarser, inflame, and granulate like the other soft parts of the joint-structure, and at last form an inflammatory tissue. The cut edge of the synovial and perisynovial tissues presents (Fig. 591) a jelly-like appearance, and is continuous with the round and pyramidal elevations above mentioned. The color of this material is light pink or yellow, with the suspicion of a green tinge in the shadows; through it run long, wavy, hardly branching vessels, and thin white lines of unaltered or scarcely altered fibrous tissue. This gelatinous material encroaches on the joint-cavity, and extends toward the skin to a degree varying with the duration of the disease.

Fig. 591.



Strumous synovitis; granulation tissue lying on the cartilage. (From a specimen in the Museum of the Royal College of Surgeons.)

¹ The first symptoms of strumous disease are frequently dated from a protracted convalescence after measles.

A shred or fine section of this material shows it to be composed of a mass of cells, round and spindle-shaped, together with bare nuclei, the whole held together by ground-substance, granulated or delicately fibrillated, and of very soft consistence.¹ The area pervaded by this material is not equally thick in all parts; in one spot it may hardly encroach beyond the immediate neighborhood of the cavity, in another it may be much thicker, while in a third place it may send out a prolongation extending a considerable distance. Wherever it exists, it invades any intervening structures; it grows in the interstices of ligaments, and gradually separates or transforms their fibres; that is, the cells of the areolar tissue which pervades those structures, forms by proliferation this sort of material.

This substance is granulation-tissue, exactly like that which forms the floor of ulcers, and produced in a precisely similar manner; the act of granulation is not confined to strumous joint-disease, it occurs also in ordinary chronic synovitis, such, for instance, as is left after an acute attack; and though in the strumous disease the granulation-tissue is unusually soft, the action itself is not peculiar to that malady; it is the after-behavior of the granulation-tissue which individualizes the disease. Thus, in the chronic stage of an acute synovitis, the granulations develop rapidly into a fibrous form of cicatricial tissue, and this tendency is, as we shall see, still more strongly marked in chronic rheumatic synovitis. But in the malady which we are now considering, the new tissue has little or no tendency to cicatrization or fibrillation; it remains, or at least tends to remain, for an indefinite time, the same unformed or embryonic material; and, then, without further organization, is apt to undergo either fatty or purulent degeneration.²

There remains yet another degenerative process which must be noticed—the *tuberculous*. For very many years past, the possibility or probability that the extreme obstinacy of strumous synovitis, such as just described, might be due to tuberculosis of the synovial membrane, has been constantly borne in mind; I myself have not only been prepared for the reception of evidence to prove the fact, but have also been aware that old and indolent granulations—tuberculous nodules—consisting in great part of giant-cells, could be found in these cases. Within the last two years, however, the subject has reached another phase.

In 1880, Dr. Max Schüller published his well-known account³ of experiments on a number of animals which he had rendered diseased by the injection of tuberculous matter, and in which he had at the same time, or at least during the same day, as a rule, injured the right knee-joint. With these experiments, and with the inferences drawn therefrom, is intimately mixed up the doctrine of a special living organism as the cause and origin of

¹ The cells are evidently produced almost entirely by the proliferation of the connective-tissue cells, emigration-corpuscles playing but a very small part in their formation.

² The anatomical condition above described is that which Sir B. Brodie called "A Morbid Change of Structure of the Synovial Membrane." The disease is what Wiseman called "White Swelling," a term which afterwards was extended to many forms of joint-disease. Bonnet (*Maladies des Articulations*) and Richet (*Maladies des Articulations*) term it "fon-gueuse." Volkmann (*loc. cit.*) names the disease "Fungöse Gelenkentzündung." Hueter (*Klinik der Gelenkkranheiten*, Bd. i. S. 77) would make distinctions among all those chronic forms of synovitis in which considerable thickening or hyperplasia takes place, naming them respectively *synovitis hyperplastica*, with the adjuncts *levis* or *pannosa*, *granulosa* or *fungosa*, *tuberosa* or *papillaris*; but these somewhat grandiose names indicate no real pathological differences; indeed, he confesses "that in the same joint these different forms of hyperplastic inflammation coexist." They are, indeed, mere variations, according to the degree and stage of the disease, according as the granulations tend more or less to advanced development.

³ Experimentelle und histologische Untersuchungen über die Entstehen und Ursachen der skrophulösen und tuberkulösen Gelenkleiden, u. s. w.

tubercle. With regard to this work and this doctrine, I can only say, while acknowledging fully and freely the great industry and patience involved in Dr. Schüller's labors, that they require much confirmation. I cannot consider them in any way conclusive, concerning what for us just now is the important point, the origin of strumous synovitis in tuberculosis of the synovial membrane. This is certainly not the occasion, nor have I here the space, to enter into a detailed criticism of Dr. Schüller's work; but I must point out that the history which I have given of strumous synovitis, is that of a very slow malady, commencing in children either a little weakened and depressed, or apparently in fairly good health, and who have either received a slight injury to the joint, or none at all. The right knees of Dr. Schüller's rabbits and dogs, after they had received into their lungs a considerable quantity of tuberculous matter, were injured ("contundirt"). "The leg did not undergo dislocation or torsion: partly because, although the ligaments were torn, very little or no blood was effused into the joint or the tissues; partly because the bones at the epiphyseal lines were fractured; that is to say, the epiphyses of both femur and tibia were torn away."¹

After injecting various forms of tubercular tissue into the animals' lungs, and damaging their right knee-joints in the way described, Dr. Schüller found in the inflammatory products about the injured knees, sometimes histological elements which he considered tuberculous, at other times such as he thought doubtful ("vielleicht als initiale Tuberkel"), at others, appearances not even colorably tuberculous.

Now it must be confessed that these animals (generally rabbits, which are prone to tubercular disease), artificially affected with acute tubercular intoxication, and at the same time with very severe traumatism of a joint, were in a state by no means analogous to that of a strumous child who has hereditary tendency to, or is actually ailing from, chronic tuberculosis, and who may have received slight or no articular injury.

Dr. Schüller describes, excellently and minutely, various conditions of low, fungoid granulations which affected the "contundirt" joints; but, of course, he could not find, in these infected and often almost moribund animals, the same forms of inflammation as in healthy creatures receiving a like injury; the process of inflammation in weakly systems tends to the production of fungous or pannus-like forms, quite independently of tubercle. And not merely must the ill state of health in these animals be taken into account, but also the fact that embolic clots are very apt to lodge in the synovial tissues, especially if injury have rendered them hyperæmic.

But let us shortly examine the results of injections and contusions in 24 animals. Of these, five were infected with phthisical expectoration; these all showed changes considered to be tubercular.² Six were infected with minute pieces of tubercular lung. Of these, one died on the fifth day, and one (a dog) was killed three and a half months subsequently; his internal organs "were extremely thickly beset with pearl-gray tubercles;" in the granulations of the injured joint were several white nodules, not as large as a pin's head, and in one place other signs ("perhaps giant cells") still less significant; the other four animals (rabbits), dying in from 15 to 34 days,

¹ Op. cit., S. 19.

² I will not here compare my histological experience with that of so practised a microscopist as Dr. Schüller, but I confess to feeling by no means sure that many of the nodular cell-accumulations described in his work were tubercle. The anatomical characters of that material are not as yet determined; certainly, giant cells cannot be accepted as conclusively characteristic. They arise in old granulations of almost any unhealed wound, where vascularity happens to be deficient, and by the same law in the persistent granulation-tissue of strumous joint or bone inflammation. I certainly could not, for instance, accept some specimens shown at the Pathological Society, as undoubtedly examples of tubercle. (Path. Soc. Trans., vol. xxxii. p. 174.)

showed spots on the synovial membrane which "may perhaps be regarded as initial tubercle." Six were infected with portions of tuberculous lymphatic glands; they died or were killed at various periods, from 12 days to 3 months, and though several succumbed to general tuberculosis, the utmost similarity that the joint-appearances bore to tubercle consisted in their presenting "masses of round, oval, and caudate (birnenform) cells ranged together, having the appearance of *heaps of epithelioid cells*" and "*colossal giant-cells*."¹ Four were infected with lupus tissue; of these none showed anything more characteristic of tubercle in the synovial membrane than "quantities of round cells in the superficial layers of the synovial membrane." Lastly, three were injected with tuberculous (?) synovial membrane; the joints of these, again, showed nothing characteristic of tubercle. Therefore, of the 24 injured and infected animals, we find that only those infected by sputum showed any clear marks of tubercle in the joint structures, save one dog infected with phthisical lung tissue.² Actual, pulped tubercle injected into the lung appears to have had little or no effect in producing joint-tubercles, even though the animal died of tubercular infiltration of the lungs, liver, spleen, and kidneys.³ It is, of course, with so careful an experimenter as Dr. Schüller, not to be doubted that the material injected was what he intended, and that it was non-putrescent. But can this last condition—non-putrescence—ever be insured with sputum? The expectorations of phthisis contain, no doubt, a certain amount of tubercular matter. The same must be said of such lung-tissue, lymphatic glands, etc., as were used in these experiments; but the experimentalist assures us that these latter were as fresh as possible (*thünlichst frisch*). On the other hand, the shreds of lung-tissue and the detritus of tubercle that form part of the expectoration of phthisis, are much changed, even before they become detached; then, while enveloped in pus or muco-pus, they and the secretion are long exposed to currents of not very pure air, by which they are moved up and down the bronchi and trachea, until finally ejected in a state particularly likely to produce, in the blood of another animal, those dyscrasias of which embolic and other infarcts of synovial membranes form a notable and integral part. It appears to me very significant, that these particular injections should have been followed by so much more marked effects than others of equally or more tuberculous substances. Neither are the subsequent experiments, carried out with fluids cultivated from tuberculous tissues, in any way more convincing; indeed, in them lies another source of possible fallacy. They show that a certain cultivated organic poison, derived from tuberculous tissues, produced in the lungs what was very possibly tuberculosis, but at the joints, again, the "perhaps initial tubercle," and certain spots of which it could only be said that "they might be considered as tuberculous formations."⁴

How far Dr. Schüller's investigations may go to prove the existence of a living organism as the generator of tubercle, does not concern us here;⁵ our task is purely surgical, and in this place only concerns the joints. With regard to these, the experiments appear to show that, even while internal organs are deeply infected with acute and subacute artificial tuberculosis, the synovial membranes, even though severely injured, will resist the infection to such a degree that, as a rule, only doubtful or "initial" signs of tuberculous action can be detected by either naked-eye or microscopic research.

¹ The italics are Dr. Schüller's.

² Did space permit, it would be easy to show—this creature's internal organs being stuffed with tubercle for three months—that the inflamed synovial membrane could hardly escape.

³ One is a little struck to find that granulations from so-called tubercular joints had no effect.

⁴ Op. cit., S. 64.

⁵ It is curious that Schüller should describe and picture this organism as a micrococcus, oval or pear-shaped, and that Koch should call it a bacillus.

Moreover, it is a very instructive outcome of these experiments, that in no single instance was a joint, that had not been artificially injured, affected with inflammation. If a tuberculous condition of body could render the person or animal peculiarly liable to fungating forms of synovitis, many of those animals, which succumbed or were killed, after a certain number of weeks or months, with lungs and other viscera stuffed or studded with tubercle, would, we should suppose, have shown some marks of joint-affection. But such a condition, save merely as regarded the direct result of injury, was uniformly absent. We know that struma and tubercle are in some way (though we know not how) closely allied; we see, again and again, children with strumous joint-maladies dying of phthisis, or of tubercular-meningitis, while still the articular disease is nascent, and certainly non-tubercular. In this fact, again, we have therefore another evidence how little prone to tuberculosis are the synovial membranes. I confess to have believed that the inflammatory granulation-tissue of strumous synovitis was very apt to be affected by tubercle; but the difficulty which Dr. Schüller encountered in producing that neoplasm in "contundirt" joints of tuberculized animals, seems to render a re-examination of the subject desirable. But although the healthy synovial membrane, and perhaps the inflammatory tissue generated from it, appear to resist the invasion of tubercle, the latter, especially when it becomes old and fungoid, yields in certain spots to other forms of degeneration. The suppurative and fatty are common; the caseous (without passing through previous phases) not very uncommon; and also not very unusual is another, the pathological place of which is doubtful, in which one sees, in certain parts of the jelly-like granulation-tissue, little spots, rather dry and dull, looking almost as if grains of fine powder had fallen into it. So small are these that, were there but one or two, they would be imperceptible, or would, at all events, escape notice; but, as they are many, they give a peculiar, almost dusty, look to the specimen. Examined with a microscope of sufficient power, these spots show a closer packing of the cells, which may be round, or more often seem by pressure to have been shaped into a variety of epithelial-like forms. They generally lie so as to give the impression of a circular or ovoid arrangement, and in the centre of this circle are frequently one or two giant-cells; indeed, it appears to me that it is the growth of these giant-cells which, compressing those around them, causes the closer agmination, and the appearance of circular arrangement above described. That pressure has some share in the matter, may be seen by the fact that, when the section passes just over or through one or two of these spots, they cause a little projection of pin-point size, or sometimes larger. Whether or no these little spots be tubercle, must be decided by some future histologist. If they are so interpreted, they are merely the tubercle of inflammatory products; even those found in the injured joints of Dr. Schüller's animals belong to that category; and I suppose it has, for many years, been known that inflammatory products, when sufficiently persistent, are apt, in strumous individuals, to become tuberculous. But that is not the question—it does not even touch the only question of real interest and importance—which is, Does tubercle ever become deposited in a previously healthy synovial membrane,¹ and give rise to a typical inflammation? At present we have no evidence that this ever occurs; and Dr. Schüller's book goes very far to prove its non-occurrence, since even inflamed synovial membranes were with difficulty infected; and since, in the highly tuberculized animals which were the subjects of his experiments, there was not found a single spot of tubercle in any one uninjured ("nicht contundirt") joint.

¹ Cancellous bone-tissue stands in the same conditions

We must now leave this digression, and continue to trace the course of diseased action in strumous synovitis. We left the joint at the stage of heaped-up granulation-elements, having little or no tendency to form tissue; we have studied these only as becoming developed in the synovial and other soft parts, and have not as yet touched on the invasion of other articular constituents. The next two steps, if disease still persists, are invasion of the cartilage and bone, and degeneration with suppuration of the granulation-tissue; but it is not an unavoidable necessity that the malady must continue—must go on to take those two steps—the progress may be arrested at the point now reached. The embryonic tissue assumes further developmental action, and gradually becomes converted into fibrous tissue, while doubtless at the same time many of the cells and bare nuclei simply melt away and are absorbed. The process is exactly the same as the filling up and cicatrization of an ulcer or open wound, healing by granulation; the result is similar healing by means of cicatricial tissue, which in this locality is called thickening. It commences with cessation of the ordinary process of inflammation, namely, proliferation of cells; then those cells already formed undergo the necessary fibrous transformations elsewhere described. There is therefore a period, an interregnum after the cessation of inflammatory action and before the commencement of that which is reparative, during which little or nothing is going on; a period which, except in bad cases marked by decided cachexia, lasts, I believe, a considerable time.

It must not, however, be supposed that this cessation of inflammation is always so early—that is, previous to the invasion of cartilage and bone—nor indeed to a certain amount of degeneration and suppuration.¹ Neither must it be assumed that after the interregnum repair always sets in. On the contrary, the malady may then enter on its next stages. These, viz., degeneration of granulation-tissue and invasion of the harder parts, have no interrelationship either of time or causation. I have often examined joints the cavity of which has been all but obliterated, and the structures around which, even to the skin, have been occupied by unaltered granulation-tissue; and also other joints in which such tissue has greatly degenerated, while the harder structures have been sound; and yet again, in other cases, I have found that while much less disease of the soft parts could be detected, the cartilages and bones have been in great measure destroyed. Nevertheless, although the period when the harder parts participate in the morbid change is very variable, I propose, because that participation is so important a factor of the whole disease, to take this event as the line of division between its first and second stages.

SECOND STAGE.—We have seen (p. 395) that the acute inflammation of a suppurating joint easily and rapidly spreads from one structure to another, and indeed all violent inflammations have a tendency to invade neighboring parts. But it is at first a little difficult to perceive how so quiet, so slow an act as strumous synovitis should be so all-pervading, how or why that process of cell proliferation should spread from the perisynovial tissue to others so unlike it as bone and cartilage. The solution is to be found in the histology of articulations. When at a certain very early stage of foetal life, the limb buds first appear, no joints exist—the cartilage which is to form the limb bones lies undivided in its periosteum; soon, at certain places, transverse rifts appear, which, spreading outward from the centre, divide that cartilage into segments. The fissure does not extend straight and simply across the whole thickness of the cartilage, but near the edge bifurcates or becomes double, so that a ring

¹ These later acts of healing are again referred to on page 421.

of that structure is separated from the rest except at its upper and lower edges, where it is still continuous with the primordial cartilage. This ring, by a series of curious fibrillar changes, becomes afterwards the synovial membrane—which therefore is, and remains throughout life, in structural continuity both with the bone and with the cartilage of incrustation. Articular cartilage is but an unossified portion of the primordial cartilage; synovial membrane is also a part of the same structure converted into a tubular membrane; the fibrous joint-capsule is a metamorphosed ring of the original perichondrium. Thus a synovitis spreads by direct continuity of structure both to the cartilage and to the bone.

The disease of cartilage which arises during the course of a synovitis is likewise inflammatory.¹ In the section on Diseases of Cartilages, the histology of *chondritis* will be more fully described. Here it may be briefly said that the cells, like those of other connective tissues, proliferate; the corpuscles, therefore, at first enlarge, and then are ruptured; leucocytes also doubtless penetrate the mass. In consequence of this cell-action, the hyaline structure is broken up into fibres, some of which are subsequently absorbed or used up by the growing cells, while others become detached, and, falling into the joint-cavity, mingle with the tissue-detritus and the fluids. Many of the fibres, however, remain, and give a velvety texture to the floor and edges of the ulcer.

Wherever the inflammation has spread directly from the synovial membrane to the cartilage, the actions above described commence at or near the surface, and may be either very chronic or much more rapid. In the former case, the change is first marked by the appearance of a white or yellowish, opaque spot, generally protruding a little beyond the rest of the surface; this is found on section to be conical, the base at the surface, the apex at a depth varying according to the age and stage of the ulcer, until the point reaches to, or is truncated by, the bone. In and a little beyond the limit of this spot, the enlarged corpuscles, ruptured near the surface, and the fibrillated, hyaline structure, are very evident. In the quicker form of ulceration, these changes, though they probably occur, are hardly to be traced. When completed, the former kind of ulcer has a coarse, velvety appearance; the latter has a clean-cut though often very irregular edge. Every excess of action must be accompanied by increased nutrition, and to support the superabundant cell growth there must be an augmented flow of blood. The hyperæmia of *chondritis* may be seen by making a longitudinal section of the cancellar bone-tissue which immediately underlies the articular lamella. The red spot or blotch exactly opposite the ulcer of cartilage is a very decisive and well-marked appearance.

But when this hyperæmia has lasted some time, it produces certain local effects; the cancellar lining membrane assumes the same proliferating action, and the cancellar plates begin to inflame, the thin parietes rapidly softening and breaking down; the articular lamella disintegrates, so that now the ulcer of the cartilage leads directly down into a granulating cavity in the bone; or, to put the same subject in other words, the granulations springing from an inflammatory cavity in the bone pass through the ulcerated opening in the cartilage, and sprout into the joint, where they mingle with those granulations that spring from the synovial membrane.

Yet a different mode whereby cartilage becomes detached (not ulcerated) must be noticed: the cancellar hyperæmia produced originally at one or two

¹ It was considered, previous to 1860, that the cartilages were, during synovitis, quite inert, and that their ulceration was caused by a rodent action of the hypertrophied fringes and pannus-like prolongations from the inflamed synovial membranes.

spots by the cartilage ulceration, sometimes spreads laterally beneath the articular lamella, and the resulting osteitis is much more extensive than the original chondritis; the cancellar plates and articular lamella consequently give way for a considerable distance beneath cartilage which is still in a sound, or almost sound, condition. That piece of cartilage therefore, being now detached, lies floating, as it were, between synovial and bone granulations, having still adherent to its deep surface a sabulous matter composed of the detritus of the articular lamella.

Thus the joint has arrived at this state: the two (or, in some instances, three) bones are no longer closed at their ends, either by cartilage or a continuous plate of bone; their cancelli, on the contrary, lie open, and from them sprout granulations, which, with those from the synovial membrane, form one mass. The unsealed bones are conjoined by a mass of granulations, in the midst of which is a cavity, usually containing pus, and there are generally also more abscess-cavities among the inflammatory tissues. The capsular or other ligaments are likewise invaded by this same material, and are thereby softened and loosened, and may in time become absorbed. It is, however, rare that the mere proliferating (granulating) mass goes on to thus entirely occupy the place of the former joint, without, in some part, undergoing either degenerative and destructive, or reparatory and consolidating acts. Thus there may be abscesses in various parts, accompanied or preceded by fatty degeneration, or, more rarely, by spots of caseation; or, again, we may find here and there a tendency to form cicatricial-like, fibrous tissue throughout a greater or less extent of the growth. All these changes we will leave for the present, in order to study certain phenomena that accompany synovitis, and, more especially, the ulceration of cartilage.

We have seen (page 378) that in acute synovitis the flexor muscles shorten very considerably, thus producing persistent flexion of the joint; this is at first merely *contraction* of a reflex character—that is to say, the *σαρξ* is actively involved—but after a time the sarcolemma and other fibrous elements shorten themselves (since the muscle is never elongated), becoming thus adapted to the decreased length. This fibrous shortening is that which I, many years ago, named “*contracture*.” If disease were now to cease, there would result a limb bound into a certain angle by a fibrous band; that angle can be diminished, that is, the limb can be further flexed, but it cannot, unless force be employed, be increased. The disease, however, and with it the muscular contraction, may not now cease; on the contrary, the *σαρξ*, with fresh vantage-hold on the shortened fibres of its sheath, acts with greater vigor, drawing the distal bone into a still sharper angle, and itself becoming more contracted. This form of shortening is always accompanied by fibrous degeneration of the muscular element, and the affected muscles, therefore, waste very considerably; the muscles, more especially the flexors, soon become little else than fibrous cords. The extensors, on the other hand, which are not thus affected by reflex tonic contraction, nor, therefore, by contracture, remain flaccid, and are prone rather to fatty degeneration, which, however, does not occur so early in the disease.

But another effect, besides flexion, follows these muscular acts at certain joints, more especially at the knee. For since the cartilages are, in part, destroyed, and the shape of the bone-ends modified, a certain loss of substance has been thus produced, which, by approximating certain points of bone, renders the ligaments somewhat looser. Moreover, those structures are, as we have seen, involved, and, more or less, disintegrated by the granulating process, which softens them and causes their fibres to be still more flaccid. In consequence, the continued drag which the muscles exercise, as above

Fig. 592.



Consecutive or pathological dislocation of tibia
backwards at knee.

described, upon the distal bone, produces not merely flexion, but a gradual gliding of the lower joint surface upon the upper, towards the side of flexion, producing pathological dislocation, or, since it is rarely complete, subluxation.¹ At certain joints, dislocation may occur in other directions than those of flexion; for instance, the tibia may be displaced outward on the femur, this being due to unusually powerful action of the popliteus muscle. Now when these contractures have persisted a certain time, another set of neuromuscular phenomena, commonly called starting pains, arise; they are clonic spasms affecting the muscles about the joint, or, when severe, those of the whole limb. Their commencement tallies, in point of time, with the hyperæmia of the cancellous bone-ends that accompanies cartilaginous inflammation. I proved this coincidence many years ago, and a long course of careful ob-

servation has confirmed that view. They appear to me exaggerated manifestations of that muscular sense that warns us of excessive pressure on joint surfaces, or of pressure in unusual and hurtful directions, and are like that general spasm of all the muscles of a limb which occurs when a false cartilage, intruding between the bones, causes violent pressure on points of their surfaces. Thus, since the period when the bone-ends become hyperæmic is not fixed, so is the advent of starting pains variable. It is always earlier in joint-diseases that begin in the bone, than in those that commence in the synovial membrane. The pains are accompanied by increasingly rapid wasting of the limb: during mere quiet contracture it was chronic; during starting pains, and in direct ratio with their severity, it becomes acute.

The etiology of these pains, the way in which hyperæmia under the cartilage may produce them, is very difficult to elucidate; they appear to me to be due to perturbed reflex action of an excited spinal cord, occurring at a time when the cerebral controlling power is withdrawn. Thus, sleep, though we think of it chiefly as it affects the mind, must also influence the spinal cord, but more slowly. Many persons twitch when going to sleep; this happens chiefly after overfatigue, or when the health is somewhat depressed.² Now, the flexor muscles of a diseased joint are, and have been for some time, in a state of persistent contraction; it must be that those muscles are overfatigued, or in an analogous state, and in all probability a certain district of the spinal cord is overexcited. Twitching of those muscles, therefore (in the period when the brain is asleep, but the cord still awake), is a highly probable event. But this twitch, which is of no importance, or is not remarked, during ordinary circumstances, drives the bone-ends together with some force, and, when they are rendered tender by disease, produces a state of pain, which in its

¹ The pathological luxation of the hip is, probably, due to other causes besides muscular contraction.

² The commencement of many spinal diseases, for example, locomotor ataxia, is marked by severe twitching.

turn causes a more violent contraction. Starting pains, therefore, are the product of unregulated reflex acts, and of joint tenderness. Subchondritic hyperemia causes additional contraction of the flexors, and thereby a spinal and muscular irritability which renders them liable to twitch with such unusual violence as the morbidly sensitive joint cannot bear.

THE THIRD STAGE of strumous synovitis embraces two processes: the one of consolidation and further organization of the granulations, the other of degeneration and destruction. It is, of course, to be understood that either of these, but chiefly the reparative process, may set in without intervention of the second stage; in other words, a strumous synovitis may be cured without ulceration of cartilages. We must also understand that in some cases destructive action will take place at one part, and reparative action at other parts of the same joint.

Process of Repair.—The consolidation of the granulations and their subsequent transformation into fibrous tissue is the same process as that which takes place in the healing of an ulcer, or in the filling up of any gaping wound. This is effected by that gradual change of embryonic granulation-cells into caudate and connective-tissue cells (placoids of Klein), then into spindle-cells, and lastly into cicatricial fibrous tissue.¹ By this means, if the process go on *pari passu* throughout the whole region of the inflamed joint, the condition of things is changed: the bones, which were formerly separated rather than united by the soft granulations, are now bound together by a firm fibrous tissue which springs, as the granulations sprung, from all the cancelli and from their opened cavities, as well as from the outer case of the bone and from the joint capsule; thus the bones may be said to terminate in a short, thick rope which binds them together, and of which the soft parts around (all that were involved in the disease) form the outer parts; this is termed “false” or “fibrous ankylosis.” If, at a later period, this cord ossify, the ankylosis becomes “true.” Or, on the other hand, if cure take place before ulceration of the cartilages and destruction of the bone surfaces has occurred, the resulting cicatricial tissue forms a hollow or tubular fibrous bond of variable thickness and strength, according to the amount of previous disease; this “thickening” may be a considerable impediment to motion. Sometimes a portion of the joint surface near the edge of the cartilage may have been destroyed, and then a process of the fibrous tissue intrudes a certain way into the joint, projecting like a pilaster from a wall. Such processes, which are not very properly called “adhesions,” generally impede mobility very considerably.²

Process of Degeneration.—Although strumous synovitis is a very slow disease, and the tissue product very indolent, yet this is not very durable; some change must take place, and if in a given time repair do not set in, a destructive process must inevitably commence; caseation is not very common, and occurs only at small points; fatty degeneration of the cells and suppuration are more usual. These two are always somewhat commingled, but very often certain tracts or spots of the tissue may break down into abscesses, with but little pathological change; wide or large suppurations, on the contrary, are, as a very general rule, preceded by much fatty degeneration, which in bad cases invades the tissues almost suddenly. This condition is marked at its commencement by a greenish coloration of the granulation-tissue, and after-

¹ A fuller account of this process than is desirable here, will be found in this Encyclopædia, Vol. II. pp. 16–20.

² I prefer to call these “fibrous bonds;” true adhesions between joint surfaces, comparable to adhesions of the pleura, are excessively rare.

wards by a dirty, muddy hue. Suppuration of one part of the granulation-tissue is generally accompanied by its spread further and further from the centre, and this more recent growth may in its turn suppurate, leading either to large pus-formations in various parts of the limb, or to isolated or slightly connected abscesses in what was the cavity of the joint, near to that locality, or at variable distances, both in the soft parts or in the bone. These

Fig. 593.



Intra-articular, periarticular, and adjacent abscess in a case of synovitis of the ankle.

may be termed respectively, "intra-articular," "periarticular," "adjacent," and "intraosseous."

Of *periarticular abscesses*, it may be said that they sometimes originate in the passage outward from the central cavity of a little pus, which sets up or encourages suppuration in its new position; but they more often arise independently, having for some time no communication with the remains of the joint-cavity. *Adjacent abscesses* of a more superficial sort, namely, immediately beneath the deep fascia, separating that structure from the muscles beneath, are not uncommon in this disease, and they may, especially if the pus be of slow formation, burrow a long way under the tough, fibrous structure. A deeper form, namely, among the muscles and more especially that sort of adjacent abscess

that travels along the bone, is much more common in osseous than in synovial joint-disease.

Intraosseous abscess of any large extent or significance is not usual in chronic synovial disease, although small foci of suppuration close to the end of the bone are often found; suppurative softening of the epiphyseal line, giving rise to diastasis, is also unusual in synovial disease, though it is not so uncommon when the disease commences in the epiphysis itself.

Any one of these abscesses may open outward; even the intraosseous, communicating after a time with one of the other varieties, gains indirectly the surface. When, however, the pus arrives at the deep surface of a fascia it does not, unless of very rapid formation, continue its course directly outward, but burrows some distance—passing sometimes along the course of a tendon, sometimes gliding in an intermuscular groove—according to the anatomical arrangement of the part. Even when it reaches the skin, slowly formed pus does not quickly penetrate that structure, but spreads itself in a radiating manner from the spot first reached, sometimes to a considerable distance.

These processes of fatty degeneration and suppuration may be almost rapid enough to be termed acute, even though the preceding stages have been very slow; they may too involve a large part of the limb, causing considerable destruction. In the mean time, the joint, loosened and broken down, becomes more and more disorganized, and the bones displaced; afterwards, if allowed to continue and if the patient survive, fragments of ligamentous or osseous tissue come away with the discharge. Rarely, however, are these forms of joint-disease permitted by nature or by art to reach these ultimate limits. Operative measures are employed, or, these being inapplicable, a kindly death terminates the patient's sufferings.

For the local changes above described do not stand alone, but on the contrary

are accompanied, and perhaps in great part produced, by considerable deterioration of the general health. As with, or previous to, any reparative changes, marked amelioration of the general condition may be verified, so, on the contrary, the commencement of degeneration or suppuration may often be inferred from a rapid deterioration of general health. Indeed, it may be taken as true that an ill state of health, or defective hygienic arrangements, will prolong this form of joint-disease, and conduce to its most untoward terminations. The patients are strumous, certain of them having a tendency to, or being actually affected with tuberculosis, and many a child who first comes under care with some articular malady, will soon after require to be treated for phthisis, or will succumb to tubercular meningitis.

SYMPTOMS OF STRUMOUS SYNOVITIS. (*First Stage*).—Strumous synovitis is far more frequent in persons below twelve years of age than later in life. When it does attack older persons, it most commonly affects one of the smaller joints, while in children it chooses one of the larger articulations; the numerical order of their proneness to this form of disease is as follows: the knee, the hip,¹ the ankle and elbow (equal); the least often affected of the large joints is the shoulder.

Various conditions may be found immediately preceding this form of joint-affection; for instance, measles, or other exanthem, with slow recovery, ill-defined and apparently causeless loss of health, and traumatism, are so frequently mentioned as occurring just before, that they all appear in different cases to act as exciting causes of joint-disease; but a certain number of patients are in the best health (save as regards diatheses), rosy, plump, with excellent appetite, etc.

If injury produce the malady, the symptoms of an acute or subacute synovitis—if measles or scarlatina have caused it, those of exanthematous synovitis—may precede the characteristic symptoms of the strumous disease. One of these, perhaps the chief, is the sort and character of the *swelling*, which is shapeless, uniform, and rounded. It is not like that of an acute synovitis, most evident where fibrous investment of the joint is weakest, nor is it marked by the passage over it of tendons, nor by the constricting force of ligaments. It is simply a swelling, not merely void of any special form of its own, but covering and concealing the form of parts beneath—the bones, their processes and depressions, the insertions of tendons and of ligaments, etc.

The consistence of this tumefaction is soft and doughy, not very elastic, and not pitting; it does not fluctuate, though by the uneducated finger it might be held to do so in certain rather softer parts, for some portions are softer, others a little harder, than the general mass;² the harder are not defined from the softer portions by any distinct edge, but any particularly soft spot is usually pretty definitely marked off from the rest.

The skin is by no means of that red typical *color* given as a symptom of inflammation; on the contrary, it is either the same as that of the neighborhood, or is white—whence Wiseman's name of "white swelling." In the worst cases, a few veins, flattened against the skin by the pressure from beneath, are plainly marked by blue, tortuous lines; they are only found when the granulation-tissue has grown with unusual rapidity, and in such cases the swelling is soft, having greater likeness than in other cases to fluctuation.

¹ I believe this to vary somewhat at different ages, and that in very young life the hip is more frequently diseased than the knee.

² I desire here to lay especial stress on the way this swelling covers up and conceals the markings of the bones; it is by this peculiarity, more especially, that the synovial is distinguishable from the osseous joint-disease.

Such an appearance, therefore, is of bad omen, and signifies considerable tendency to fatty and suppurative degeneration.¹

Pain is, in the first stage of strumous synovitis, a very variable symptom. In many cases it is at first absent, and the disease may only be discovered by means of the swelling, or by some sign of lameness; this appears to be produced rather by some inaptitude in movement—an inability usually to quite straighten the joint—than by any pain. If at this period the surgeon endeavor to straighten the limb, signs of pain will be elicited; but he may flex it, though perhaps not to the full extent of its normal movement, without causing any pain. When the disease has continued a certain time, the joint becomes somewhat painful, but throughout this stage not severely so, a dull aching, or a sense of distension or of gnawing, being alone complained of. In two cases, one observed in 1858, and one during the present year, 1882, a feeling of considerable cold in the joint was noticed. I am not inclined to attach importance to the sort of sensation experienced, but it should be noted that considerable suppuration occurred in both the instances last referred to.

Another sort of pain, viz., *tenderness*, that is, sensitiveness to pressure, must be especially noted. During the early part of the disease, the joint may be handled without producing any pain; but very soon a certain spot, peculiar to each joint, is found to be impatient of pressure, and in most joints this spot is that to which afterwards the chief shock of starting pains is referred. In the choice of treatment it is very important to be acquainted with these localities: they are:—

At the *shoulder*, while the hand is lying on the anterior aspect of the trunk, at the front and outside; that is, in a line drawn straight down from the acromio-clavicular joint for about an inch.

At the *elbow*, behind the joint, where the radius is articulated to the humerus.

At the *wrist*, at the back, just outside the extensor indicis tendon.

At the *hip*, if there be any pain at the commencement of the disease, it is at the inner side of the thigh, just behind the origin of the gracilis muscle; afterwards it shifts to a more constant place, behind the great trochanter.

At the *knee*, the tender point is on the inner condyle, about half an inch from the edge of the patella.

At the *ankle*, it is in front of the outer malleolus, about the place where the peroneus tertius muscle crosses the joint.

These spots in their respective joints continue tender while the formative, or rather the proliferating, processes are sufficiently active to be properly considered as inflammatory. When that activity has ceased, or has so abated as to remove the action from the inflammatory class—that is, when the tissue does little or nothing more than maintain its vitality—the tenderness of these localities ceases.

Heat, either local or general, is in strumous synovitis absent; the surface-thermometer, applied to the joint, does not rise any part of a degree, nor is there in this stage any pyrexia.

But the symptoms of the disease are not confined to the immediate vicinity of the joint; the limb is flexed, and the limb-segment above, and to a lesser extent that below, become wasted. Any attempt to straighten the joint gives pain, and causes the flexor muscles to start into strong relief; they may be felt tight and hard beneath the skin. Quite at first they feel like, and merely are, muscles actively contracted, but after a time they come gradually to resemble cords put on the stretch. As the disease goes on, the joint,

¹ This marking of veins must not be mistaken for the more copious network of malignant disease.

unless prevented by art, becomes more bent, and at the same time more painful; the child is more cautious in using the limb, and perhaps wakes up occasionally at night, crying.¹ The surgeon, who, if careful, will have kept measurements of the part, finds the joint increasing, the limb wasting, and the child looking more worn and out of health. He will be aware that his patient is getting worse, though no new symptom has arisen.

The *second stage* is now imminent, its advent being marked by *starting pains*. These have been already referred to (see p. 420), but they merit here a fuller description, since they are most frequently met with and most perfectly developed in those forms of joint diseases which originate in struma, not because the diathesis has any direct connection with this symptom, but because scrofulous diseases attack more especially children in whom the spinal motor system is very mobile. At first, and often throughout the case, these pains only come on when the patient is sinking to sleep; he is quite placid, and apparently not suffering, when suddenly he twitches as though startled, and breaks into a sharp scream of pain, crying for some time before he again tries to sleep; this may be repeated several times before at last complete unconsciousness comes on. Some children dread these starting pains so much that they keep themselves awake as long as possible; but it is difficult, since means of comparison are wanting to such young persons, to make out exactly what the pain is like.² It seems as though it did not at once subside, since (but this in some cases may be mere alarm) the crying usually goes on for some time before the child tries to sleep again.

This symptom may be taken in strumous synovitis to indicate commencing ulceration of cartilages.³ Moreover, the extent and intensity of these pains are the measure of the amount and rapidity of the ulceration.

When this symptom has lasted a certain time, another, which I have been accustomed to call *intra-articular tenderness*, makes its appearance. My observations, clinical and anatomical, lead me to believe that this symptom never occurs unless, the articular lamella having given way, the bone cancelli are open to the joint. In seeking for this phenomenon, very great care is necessary to avoid any movement of the joint, which often causes pain, but not of the sort in question. Neither must alarm or dread that something painful is about to be done, be mistaken for real pain.

About this time generally, but sometimes during the latter end of the first stage, the distal bone of the joint may be *moved* on the proximal one *in abnormal directions*. The tibia, for instance, may be made to glide sideways, or to rotate a little on the femur; the ulna will also glide laterally on the humerus, etc. This symptom is, according to its extent, of evil augury; occurring early, it shows unusually rapid invasion and softening of the ligaments; occurring at a later period, and to a greater extent, it shows that the tissues have been much involved, and that degeneration has set in.

Both these symptoms may be combined with *subluxation* or *complete dislocation*,⁴ which is much more common and of earlier occurrence at certain joints than at others. In many cases the shoulder is slightly displaced for-

¹ This is not the sort of pain to be described hereafter; the waking is not with a sharp, sudden cry, but there are at first restless movements in half sleep, and then a slow commencement of weeping, which usually is before complete awakening.

² An older patient described them to me the other day as being like what is felt when a dentist thrusts a hard instrument against an inflamed and carious tooth.

³ We shall see hereafter that in epiphyseal joint-disease it has not quite the same meaning, since hyperæmia of the joint-end is in that malady a very early condition, not a secondary effect of chondritis.

⁴ Some bones, as the ulna at the elbow, are, by their formation, precluded from pathological luxation.

ward. The ulna at the wrist is very prone to be thrown backward. The hip and the knee are both very subject to pathological dislocation; in the former this is generally complete, in the latter incomplete, and very early; indeed, a certain amount of backward displacement of the tibia is, even during the first stage, usual, unless the case have been skilfully treated.

Joint-crepitus.—Very often, when the limb is moved either in a normal or abnormal direction, a distinct, bony crepitus is felt. This symptom, when it occurs, is direct evidence that the cartilage has disappeared from both bones. Its absence cannot be taken to indicate non-ulceration with any certainty; for granulation-tissue may prevent the contact of the otherwise bared bones, or, what sometimes though rarely happens, the loss of substance on one bone may not be opposite to that on the other. A nutgall-crepitus, that is, one which does not quite feel like two bone-surfaces rubbing together, may indicate cartilaginous ulceration on one bone only; but it is hardly distinguishable from fibrous or ligamentous crepitation. In some cases crepitation is present during a certain period, and may then disappear—either to reappear, or to remain permanently absent. This last event indicates a tendency to amelioration of the local condition by the occurrence of fibrous ankylosis.

At this time *abscesses* within the joint or elsewhere may be developed; although they are more particularly characteristic of the third stage, yet their commencement is often here.

The symptoms of the *third stage* are either such as mark consolidation and repair, or such as indicate degeneration and further ravages.

Reparative processes mark their advent always somewhat slowly, but more especially so if they have fortunately commenced during the first stage of the disease, or, indeed, during the earlier part of the second, before ulceration of cartilage has gone very far, or before abscess has formed. In the former case, the slow amelioration is marked by an improvement in the general condition; the child's sleep is less perturbed; his appetite is less capricious; he eats in a more business-like manner, and no longer requires to be tempted with tid-bits or constant variety; his complexion is clearer and brighter; and the tell-tale dark marks under his eyes disappear. While these improvements are taking place, the disease is generally in that state of interregnum above referred to (p. 417); the joint no longer increases in size, and after a time becomes harder; the special points of tenderness (p. 424) are no longer painful on pressure; ultimately decrease in size may be verified, and the bone appears less distant from the surface, while its elevations and depressions reappear. The amount of this resumption of form depends on the previous degree of swelling, for the greater part of the inflammatory products do not disappear; the deeper structures still remain covered by them, only now more fully developed, and therefore occupying less space. If before repair has begun the cartilages have ulcerated, we may add to this account that, simultaneously with the improvement in general health, the starting pains diminish both in frequency and intensity.

When abscesses have already opened outward, the gradual diminution and cessation of discharge is very marked; but still more striking is it to see the exuberant sprouts of granulation slowly recede within the openings; they do not shrivel and disappear, but are really withdrawn, as a snail retires into its shell. This is due to the contraction which the deeper inflammatory products undergo during fibrillation—the indication of which may be seen for years afterwards in the depressed cicatrices which such abscess openings leave behind.

This fibrillation and hardening of the granulation-tissue is the first step towards false ankylosis, if the whole joint and its surroundings have been

occupied; to mere thickening and restrictions of movement, if only the perisynovial district has been involved; its progress is marked, first by disappearance of any pre-existing abnormal mobility, and then by increased stiffness of the limb. When the process is complete, the diseased joint is nearly always smaller in circumference than the sound one. This is due in great measure to the cicatricial contraction of the newly-formed tissues, but may also be owing to arrest of epiphyseal growth. That subject will be more fully discussed hereafter.

The *destructive processes* are at first often masked; they may not attack the whole area of disease, but only localities here and there, while elsewhere actions of an entirely different character may be going on. Indeed, it is in some cases, and for a certain time, difficult to say towards which goal the action is tending. The key is to be found partly in the local, but also very much in the general conditions. While the hectic decreases, or, at the least, remains stationary, some hope may well be entertained; but if the thermometric fluctuations increase, showing a generally higher temperature, but with wider range between morning and evening, the prospect is bad. This condition of temperature is accompanied by a more capricious state of the appetite, greater restlessness, and probably profuse night-sweats. Diarrhœa also sometimes supervenes. The state of the spleen, liver, and kidneys must be carefully investigated. The local signs are increasing softness and size of the joint, while the limb below, as well as above, wastes more rapidly. I have also learned to look upon a desquamative condition of the skin over the joint, and immediately above and below, as very suspicious. The desquamation is not furfuraceous, but in large flakes, the size of the flat surface of a split pea, and these are often of a light-brown color, a tint darker than the skin of other parts. The bones become more and more movable in abnormal directions, the malposture continuing nearly always in the direction of flexion, and the subluxation increases. At last any doubt is set at rest by the appearance of an evidently fluctuating spot, near to or just beneath the skin; yet even now the pus does not rapidly cause distinct pointing, but a slightly pink hue, which, although it very rarely assumes the deeper tinge seen in acute forms of abscess, gradually deepens a little, and at the same time spreads. Examination of such a spot will show that the pus is separating the skin from the underlying tissue. When an opening, natural or artificial, is made, a good many flocculi come away with the ill-formed pus, and soon afterwards fresh granulations, pale-yellow and pus-sodden, crop out, and generally overlie the skin all around the opening. The pus then does not escape, as in the sinuses of caries, by a central opening, but by various interstices in the granulations, and by the chink left all around between them and the edge of the skin. If a probe be passed in here, it may, as a very general rule, be carried round under the corium a considerable distance from the wound. The skin is "undermined." There may be several openings of this description, sometimes even a long way from the joint. As a rule, they are chiefly on the limb-segment below, but also are not uncommon on that above the joint, where, however, they are usually less distant.

As the disease still goes on, the hectic and exhaustion increase; yet patients do not die of joint disease alone, but of affections of the viscera. Very many young children succumb to tubercular meningitis, which, however, usually destroys life at an earlier stage of the malady than that to which we have traced strumous synovitis. Those who have survived thus far usually die either of tubercles in the cerebral meninges or lung, or of lardaceous disease of the abdominal organs (liver, spleen, and kidneys). When the presence of the latter complication is feared, the condition of the urine,

the color of the skin, and the position of the two first-named glands, should be carefully investigated from time to time.¹

TREATMENT OF STRUMOUS SYNOVITIS.—Struma, as a constitutional condition, must be treated according to the type which in each case it assumes; the delicate, thin-skinned type requires the use of tonics, such as iron, quinine, maltine, and cod-liver oil, while if iodine in any form be given, it must be used cautiously and in combination with the other remedies. But the other form, that with thick connective tissues, is not benefited by the administration of the nutritive tonics. Cod-liver oil is especially, in my experience, useless, if not injurious in these cases, but occasional purging,² and the use of iodine, the mineral acids, and vegetable bitters, are indicated. But this is hardly the place to describe the treatment of such constitutional conditions; I wish, however, to give a broad outline of those methods which appear to me most suitable.

The *local treatment* of a commencing strumous synovitis consists chiefly in rest, care being taken that the limb is in good position. In a very early stage of the disease, there is no difficulty in securing these desiderata. Upon the limb, held by an assistant in the proper posture, a flannel or Domett bandage may first be applied, and over this may be moulded a poro-plastic or leather splint; or if it be preferable, as it is in some cases, a plaster-of-Paris bandage may be employed. But it must be pointed out that as cases even in their earliest stages differ, so there are decided reasons for choosing one or the other of these appliances. If the disease have commenced in a slow, painless enlargement, and if the swelling be soft and the signs of struma strongly marked, the local disease is likely to be of a bad type. Hence, as probably some local treatment will be necessary, I should prefer in these cases a removable apparatus; while when the disease has begun more rapidly, perhaps following some traumatism, and when the signs of struma are not strongly marked, we may, especially if the tumefaction be moderately hard, use an immovable appliance, trusting to mere rest as a curative measure. But here again we are confronted by another difference. There is no doubt that the child's condition is not improved by confinement to bed; if the disease be in an upper limb, this subject presents no difficulty, but if in a lower, we must combine perfect rest of the diseased joint with bodily exercise. To American surgeons is, I believe, due the first idea of putting a patten or high shoe on the sound limb, giving the child a pair of crutches, and letting him get about with the foot of the unsound leg carried some inches from the ground.

These appliances and aids are those which I use in the early stage of strumous synovitis, and whether I apply a double case of leather or felt, or a starched bandage, I always let my patients get about at the earliest possible period; never confining them to bed if the disease be in an upper limb, and only for a few days if it be in a lower. The rest afforded by properly made appliances of this description is perfect; nor have I ever found any difficulty in the details. But if the surgeon be called to the case when already contraction of muscles has produced a certain amount of fixed flexion, he must adopt measures to reduce the limb to a proper posture. This may be done either suddenly or gradually. The former plan may be most advantageously employed at almost every joint, with the exception of, in some cases, the knee and the hip. It simply consists in giving to the patient an anæsthetic, and with the

¹ For further considerations regarding pulmonary or cerebral tuberculosis and lardaceous disease, see p. 474 *et seq.*

² In this condition the intestinal canal is frequently clogged with viscid mucus.

exercise of only slight force putting the limb into the desired posture, and fixing it by means of a rapidly drying plaster-of-Paris bandage, which must be allowed to harden sufficiently before sensibility returns. I have insisted upon slight force, because I deprecate at this stage any replacement by much stretching; if ligaments or muscles be by too great an exercise of power rendered tense, they cause the two joint surfaces to press injuriously on each other. It is far better to put the limb nearly into the proper posture by gentler efforts; to retain it there for about ten days; and then to remove the bandage, and make a second attempt. Very often, even without an anæsthetic, the joint can now be easily reduced to a good position; if not, ether may again be given. The avoidance of an over-amount of force is especially to be inculcated in diseases of the knee-joint, which, under such circumstances, is very apt to suffer posterior subluxation. The gradual reduction in still early malposture may be carried on in the same way, but without anæsthesia. An assistant holds the limb as nearly as possible in the required posture, while the surgeon fixes the appliance; in a few days a much further step may be gained, and so on until perfect posture is acquired. This plan answers admirably for the elbow and wrist. At the ankle, it sometimes happens that the sural muscles produce considerable extension of the foot; the position of their tendon, so far behind the joint, and the peculiar ease with which those muscles are thrown into painful cramp, render it sometimes advisable to divide the tendo Achillis previous to reduction, rather than run the risk of the pressure which would be produced by a forcible replacement. This is the only tendon which ought to be divided for the purpose in question.

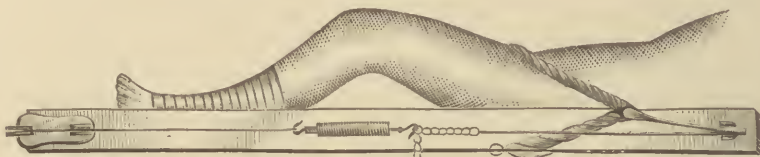
But of all joints, the knee requires in these manipulations the greatest care,¹ and presents the greatest difficulty. If the flexion be pretty strongly marked, and endeavors be made to place the limb straight, the upper end of the tibia may slowly glide back as the lower end comes forward. The surgeon finds that he is producing a partial dislocation backward. Sometimes that malposition already exists to a slight extent, and to attempt rapid replacement would then be a decided error. Hence, in strongly-marked flexion, or when some displacement is already present, it is far better to trust to weight or elastic extension. This may be effected by a strip of plaster applied on both sides of the leg, so as to form a loop below the sole, and rendered more firm by circular strapping or bandaging. The loop is fastened to a cord which plays over a pulley at the foot of the bed, and to the other end of which a weight is suspended. Dr. Sayre recommends that another band should pass under the upper part of the calf, the weighted cord attached to which runs almost perpendicularly upward to a pulley in the ceiling. I have not found this efficacious; it tends to keep up the flexion, and cannot act in reducing or preventing backward displacement unless a third force hold down the lower part of the femur.

I have found a simple "extension splint," acting by elastic force, extremely efficacious. It is like a Desault splint, with the addition that between the forks a pulley plays on a straight axle, and from the ends of the fork a steel wire projects inwards, carrying a pulley which works below the sole; at the upper end, and projecting outwards, is a steel bracket, also bearing a pulley. This splint should reach from a little below the axilla to about four inches lower than the foot would be if the limb were straight. Plaster looping under the sole is applied as above; the cord passes from the loop over the lowest pulley, and, running up outside the splint, ends in an "accumulator," the upper end of which is supplied with a wire hook. A perineal band embraces the upper part of the patient's thigh and the splint; it carries a cord,

I do not even except the hip, which forms, however, the subject of a separate section.

which, passing over the upper pulley and down outside the splint, ends in a chain; now, by stretching the accumulator so that the hook can be hitched into any chosen link of the chain, the appropriate amount of extension can be produced. There is no occasion for bandaging, save around the lower part

Fig. 594.

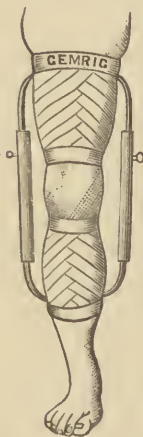


Barwell's extension splint.

of the chest, until the limb is nearly straight; indeed, the apparatus will work perfectly without any bandage at all, but an attendant must, as the knee straightens and the foot descends, hook the accumulator higher and higher on the chain.

A case which has advanced far enough to require correction of the sort described, will, in all probability, require somewhat lengthened treatment. At first, while the inflammatory symptoms are pretty strongly marked, and advancing from the joint into the surrounding parts, perfect rest must be secured by some of the means indicated for the treatment of acute synovitis. If the elbow or wrist, and sometimes if the shoulder, be the seat of disease, it will probably not be advisable to keep the patient in bed more than a few days. But if the disease be in a lower limb, a longer stay in the horizontal position becomes necessary. As soon, however, as the more pressing symptoms of inflammation have subsided, the patient must be got up, and be allowed to move about with such appliances as shall keep the affected joint at rest, while permitting exercise of other parts of the body.

Fig. 595.



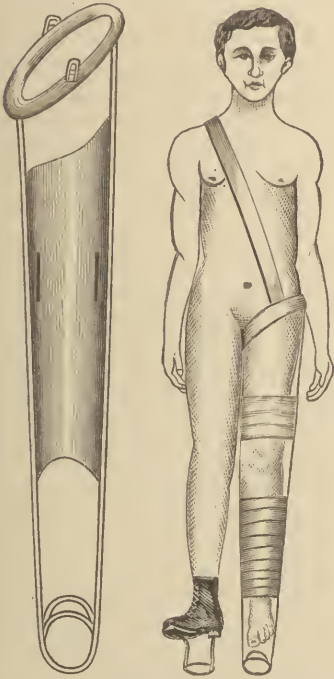
Sayre's extension
splint for disease of
the knee-joint.

American surgeons have worked very well and successfully in this direction. Taylor's long splint, or Pancoast's apparatus, originally devised for the hip, but likewise applicable to the knee, if additional straps higher on the thigh and lower on the leg be superadded, answers this indication extremely well. Dr. Sayre's extension method is, I believe, much used in America, but in Europe the use of plaster for making extension has not been found very successful; partly because of skin irritation, partly because of loosening and the necessity for frequent renewal. Thomas recommends the same splint which he uses for knee-disease in bed, to be also employed in walking with crutches, as shown in Fig. 596; the ring at the lower part being turned transversely so as to give sufficient width to the tread. The instrument, however, is somewhat heavy and clumsy for use in this way. Its chief point of improvement over Taylor's and Pancoast's appliances, lies in the substitution for their too yielding and flexible pelvic and perineal bands, of a firm metallic ring encircling the upper part of the thigh, and in the furnishing better support by means of the leather apron instead of the too narrow calf and thigh plates.

A very valuable apparatus is one to which, during the International Congress of London, Dr. von Wahl, of Dorpat, drew my attention, and in the devising of which he bore some part, though the chief merit of the invention

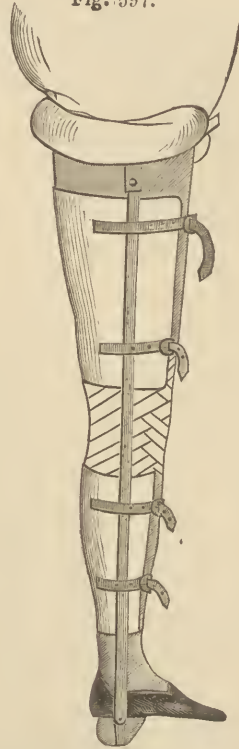
is justly ascribed to Dumbrowski.¹ The metallic thigh-ring of Thomas is retained, but, being made of steel, is capable of being opened to receive the limb, and is provided with a strap in front to secure it firmly. The apparatus is thus made: first, on the thigh and leg, and also, in disease of the ankle,

Fig. 596.



Thomas's splint for disease of the knee-joint.

Fig. 597.



Dumbrowski's splint for disease of the knee-joint.

on the foot, are moulded splints of felt, soaked in water-glass; these entirely encircle their respective portions of the limb, only leaving a slight gap in front. Accurate measurements are taken of the length of the different limb-segments, and strips of sufficiently strong metal are cut accordingly, one for the outer and one for the inner side, reaching from the thigh-ring to the malleolus; when the knee is affected, no hinge lies opposite that joint, but one is placed at the ankle, the rods below which are united a sufficient distance beneath the foot by a sufficiently broad sole plate. If, on the contrary, the ankle is the diseased joint, a hinge lies opposite the knee, but there is none corresponding to the ankle. These appliances being ready, and the water-glass splints dry, these latter are removed from the limb, and are riveted to the metals; straps are then sewn on, and the mechanism is ready for adaptation, which is effected by a fresh soaking in water-glass, and by bandaging and strapping on the limb. When all is dry, the patient is allowed to walk about; of course, at first, a couple of sticks, or even crutches, must be used for the sake of balance, but they may very soon be discarded. If the instrument have been rightly made and applied, the foot does not come to the ground; the weight falls on the sole plate beneath the foot, and is transferred by the metal rods to the ischium. The advantages of this splint over

any other with which I am acquainted, are that it fixes perfectly the diseased joint, leaving the others free, and obviates all weight-pressure on the joint-surfaces; moreover, after a very little practice, the patient is able to walk steadily and securely without crutches, thus leaving his hands free for employment or amusement. I can speak from some experience of the great efficacy and value of this splint; and the more I see of strumous joint disease, the more evident does it become to me that fresh air and exercise are great aids, if not essential to its cure.

But occasionally, when the limb is in or has been put into good position, and when all has been done to prepare it for some such splintage as has just been described, inflammatory symptoms and pain do not sufficiently abate. This mostly happens when neglect has allowed the disease to advance, when the strumous habit is strongly marked, or when bad food and hygiene have depressed the health. Starting pains show that the bones are becoming involved, and perhaps increase of the soft swelling marks a tendency to abscess.¹

Among our most potent remedies must be mentioned strong but carefully applied pressure. This may either be carried out by using an adhesive plaster—the *emplastrum resinæ*, the *emp. ammoniaci c. hydrargyro*, the *emp. plumbi iodidi*, or, if a more rubefacient action be desirable, the *emp. cantharidis*²—or the joint may be compressed with a bandage of elastic webbing, which I prefer for this purpose to the whole-rubber bandage of Martin. Care must be taken not to exercise such constriction as to produce œdema of the limb below; and it is always advisable first to bandage the parts below the joint. Stronger and more even compression can be obtained if the part be first covered with a tolerably thick layer of cotton-wool; and this keeps purer and sweeter if a little spirit of camphor be sprinkled over it. Careful bandaging of this sort will remain firm a long time on the splint.

If these methods be successful, one of the locomotion splints may be applied, pressure being still maintained. In some cases nothing more is needed, but in some there comes a time, when all inflammatory symptoms have subsided, when the special points of tenderness no longer give pain on pressure, and when motion within certain limits produces no discomfort, and yet the swelling persists, nor does it become, in any appreciable degree, harder. Under these circumstances, the parenchymatous injection of tincture of iodine is often valuable. The parts are in the same state as an indolent ulcer, with soft, flabby granulations, such as we touch with nitrate of silver or with sulphate of copper. The strength of the iodine solution should be at first thirty or forty minims of the tincture in a fluidounce of water, and this proportion may be in a little time increased up to two or even three fluidrachms; the quantity to be injected is about half a fluidounce, by means of a syringe, like, but larger than, that used for hypodermic injections. The needle should have lateral perforations, and must be inserted obliquely so as not to enter the joint-cavity. After using about half or a third of the contents of the syringe, it may be somewhat withdrawn, and then directed with a different obliquity; and this proceeding, once or twice repeated, will soak a large bulk of the tissue through a single skin puncture.

Another mode of treatment is by shampooing or rubbing (*massage*),³ and by making passive movement. In the former, the chief force both of move-

¹ Even these conditions, if slight, need not deter the application of splints for locomotion; but if severe, and more especially if their progress be rapid, it is wise first to lessen or subdue them. For this purpose, the use of flying blisters allowed rapidly to heal, or of nitrate of silver solution (5j-5iiss ad f5j), or of strong iodine paint, is valuable.

² All these are preparations of the British Pharmacopœia.

³ Mosengeil, *Verhandlungen der Deutschen Gesellschaft für Chirurgie*, 4ter Cong., 1875.

ment and pressure should be centrifugal; but I cannot credit such great differences of effect as are said by some to follow slight variations of the method. Passive movement is invaluable in two conditions—either as a means of stirring into healthy action an indolent tissue that will neither consolidate nor become absorbed, or for preventing close and stiff ankylosis when tissue is consolidating. Used for the former purpose, we should be perfectly sure that actual inflammation has subsided, and should always begin the method cautiously, both as to range and duration. It may advantageously be combined with rubbing, and the limb must be returned to the splint and absolute rest as soon as the sitting is over. The advent of pain or additional swelling, for the joint should be measured before the next attempt, should cause postponement for awhile of the treatment.

The other object of passive movement, viz., to obviate fixity of the joint as much as possible during the consolidation of inflammatory products, is a most important part of rational treatment. This may be intrusted, under surgical direction, to a rubber; but it is preferable to let the patient also take part in the movements,¹ as thereby a certain amount of active muscular exercise is likewise obtained. Thus a great deal may be done by attaching a weight to the limb, and letting it swing. For the knee, a weight of from one to three pounds may be tied below the sole by a bandage or napkin; the patient, seated on a table, lets the weight swing, lifting it a little higher at each gyration, day by day. This brings the leg towards flexion. If it is to be brought to extension, the patient may lie prone upon a sofa, with the lower half of the leg projecting beyond the end, and the weight may be secured in front of the ankle; he is to lift the weight a few inches by the power of the hamstring muscles, and let it fall again, alternately. For the ankle, an excellent plan is to let the patient place the foot on the treadle of a lathe or sewing machine, kept in motion by another person. Sometimes it is necessary that he should steady the knee by pressure with the hands. It is not needful to describe the simple devices for applying these principles to the joints of the upper limb.

The treatment of abscess must, to some degree, depend on its position outside or inside the joint, and also on its more or less rapid formation, especially with reference to the condition of the surrounding parts. An abscess which forms rather slowly within the much contracted joint-cavity, should only be treated by incision or puncture either when tension becomes considerable, or when the pus has pretty nearly approached the surface; in either case, the abscess should be evacuated after one of the methods to be immediately described. Adjacent and neighboring abscesses should be emptied when detected, more especially if the deterioration of the health, and the increased softness and boggiess of the tissues, give evidence that more of the inflammatory tissue is about to give way.

For the kind of pus contained in such abscesses—containing flocculi and tissue-débris—aspiration is useless, and it is better to open such collections with a straight, narrow bistoury, under pressure of an elastic bandage, in the manner already described (p. 388). But if the pus have formed quickly, and if a great deal of the granulation-tissue is evidently breaking down, the best method is to make a free incision, and to pass in the finger and remove from around the abscess all the suppurating and degenerated material; this may even be done on both sides of the joint. Some free oozing takes place at the moment, but by mopping out the cavity with sponges, soaked in a solution of chloride of zinc, forty grains to the ounce, and afterwards by using firm

¹ Bonnet (*Thérapeutique des Maladies Articulaires*) has described a number of mechanical contrivances, which, for the most part, are of no practical value.

pressure, not only is all bleeding stopped, but union between the sides of the large cavity takes place—and the joint may from that moment progress towards cure, of course with more or less ankylosis. If a sinus be left, or if the narrower opening with a bistoury have been practised, hyperdistension by means of an India-rubber tube connected to a ten-ounce syringe, is often valuable. The fluid employed should be somewhat stimulating—chloride of zinc or iodine solution, as above described; sulphuric acid and water, in equal parts, is too destructive a material for either hyperdistension or washing the joint; some patients have, I am aware, recovered after its use, but a good many have succumbed.

An abscess running along the bone usually communicates with an intra-articular abscess; the worst form is that which runs upwards. In these cases an opening should be established at the lower end (near the joint as a rule), a pad placed over the course of the abscess, and a bandage applied from above downward. Hyperdistension may also be employed, a gum elastic catheter, through which the fluid is to be injected, being passed along to the further end of the suppurating track, and pad-pressure being afterwards applied. Abscesses which run downward come to the surface sooner than those with an upward direction, and they close more quickly; when opened, they should be injected with a stimulating lotion, and a drainage-tube inserted which may gradually be withdrawn and shortened, so that the abscess may heal from the depth toward the surface.

Sometimes, in spite of the utmost care and skill, the disease continues to get worse, and the abscesses discharge freely, débris of fibrous tissue and portions of bone being thrown out with the pus. Yet, though we may despair of the joint, we need not, in many of these cases, despair of the limb; my experience at two homes for cripples has shown me that patients may recover even after much tissue and a great deal of bone have been thus lost. It is scarcely necessary to point out that a good position of the part must be maintained, so that, when repair takes place, the limb may not, at all events, be an incumbrance; nor need I insist on the necessity of watching the case in several different directions. The condition of the lungs should be frequently ascertained, as should the size and state of the liver, and the color and kind of alvine excreta, while the urine should be frequently examined. Patients do not die of the articular disease, but the wasting from profuse discharges, and the irritation, induce tuberculosis of the brain (if the patient be very young) or of the lung, as also lardaceous disease of the liver, kidney, and spleen; these are more fully referred to in another section of this article.

RHEUMATIC SYNOVITIS.

Pneumatic synovitis or *articular rheumatism*, in those forms which come under the surgeon's care, is a subacute or chronic disease, primarily due to diathetic conditions, but generally excited by exposure to cold and wet. Traumatism, as by a blow or strain, is sometimes superadded, and then appears to act as a direct excitant of rheumatic action.¹ It is humiliating to confess that, after all the attention and care bestowed upon the subject, we do not as yet know what rheumatism is; but, as always happens when knowledge is scant, speculation is abundant. The lactic-acid, micrococcus, and malarial hypotheses are all without proof; no excess of lactic acid has ever been found

¹ I was attending the son of a noble family in London, and was asked to look at a footman who had sprained his back and one leg by slipping while carrying a heavy portmanteau; for five days his symptoms were by no means decisive; on the sixth day they developed into a rather severe attack of acute rheumatism. No exposure of any sort could be traced.

in either the blood or the urine, and no microzyme has as yet been detected, nor does the disease comport itself like what we know of maladies thus produced; while the very varying circumstances which attend the occurrence of rheumatic fever, contradict the idea of a malarial origin. Some writers maintain that the malady is a neurosis, localizing it in the spinal cord; and certain points in the natural history of multarticular, acute and subacute attacks, tend to support such a doctrine. For the present, however, we must be content with studying the anatomy and semeiology of rheumatism, and shall be aided in our comprehension of subacute articular affections by first glancing at the phenomena of the acute disease. Acute rheumatism is a fever accompanied by severely painful, multarticular inflammations, and by profuse acid perspirations, during which the very scanty, high-colored urine contains a considerable excess of urea, and also a less excess of uric acid.¹ The blood has the usual alkaline reaction, but contains a superabundance of fibrine, viz., instead of 0.2 (the normal percentage) 1.0 in a 100 parts. The joint-inflammations, though severe, are generally transient, and often metastatic, either to other joints or to internal parts, especially to the heart. The inflammations, whether articular or internal, are especially partial to fibrous tissues; they hardly ever lead to suppuration, but to thickening, to adhesion between opposed surfaces, and to fibrinous deposits and vegetations upon those which are free.

The usual course of acute rheumatism is to get well, leaving neither joint-disease nor heart-disease behind; sometimes, however, the heart does not recover, and in some cases the patient appears quite well and remains so for a certain time, and then heart-symptoms slowly begin to show themselves. A similar sequence of events occurs in the joints; most patients get perfectly well,² while certain other patients recover from the pyrexia and all constitutional symptoms, though in one or perhaps two joints inflammation continues; other patients appear perfectly well, but after an interval one joint, generally the knee, and occasionally other articulations also, become diseased. In the former of these conditions, all marked pyrexia having subsided, the one or perhaps two joints which remain affected, have within their cavities but very little excess of fluid, and even this is transient; but, on the other hand, there is a good deal of fibrous thickening of both synovial membrane and parts around, and even the neighboring bursæ and tendinous sheaths do not escape. In the most marked cases, the fibrinous effusion lines the inner surface of the synovial membrane, massed into undulations separated by rugæ running across or around the axis of the joint. There is no appearance of fringe-hypertrophy; indeed, these appendages are incrustated and overspread by the solid effusion. There is some near relationship between this form of disease and dry synovitis (page 379), and, as in that affection, rapid ankylosis may take place.

Similar but much less rapid and excessive change appears to accompany disease produced in very rheumatic persons by exposure, or by some slight traumatism, or occasionally to follow, but after an interval, acute rheumatism. At first there is a certain amount of intra-articular secretion, which becomes slowly or rapidly absorbed, giving place to synovial and periarticular thickening, which, though obstinate, also after a time disappears; but the condition is very prone to recur at irregular intervals, generally provoked by exposure, overexertion, or some indiscretion in diet. In still a third form

¹ The deficiency of water thus excreted is probably in part due to the great quantity eliminated by the skin.

² Save a proneness to rheumatic pains on any exposure, and an augmented liability to rheumatic fever.

the fluid effusion may not be absorbed, or if it be so reappears very soon, and then continues to increase; this constitutes one species of hydrarthrus.

We will study a little more closely the former of these conditions. At first there is hypersecretion into the joint, but afterwards the by no means considerable swelling is hard and elastic, and evidently fibrinous. Those mere physical acts of inflammation which consist in emigration of leucocytes and proliferation of tissue-cells, are the same in all forms of the process; the diathesis, or the species of inflammation, determines the after-fate and development of that cell-growth. Rheumatic, parenchymatous inflammation tends to produce from the cell-tissue fibrinous material, and that hurriedly. The joint and its surroundings are occupied by a coarse fibrous tissue, formed by closely compacted fibre-cells;¹ this is of a light reddish-brown or fawn color; it is of variable thickness at different points, according in part to duration of disease; it may closely approach the skin, and encroach more or less on the joint-cavity, transforming its inner surface into a series of rugæ, which run in a direction around the joint; these are separated by deep, narrow fissures; the tissue is thickest where normally the membrane is most lax. There are no dendritic, hypertrophied fringes; indeed, the fringes themselves are included in or engulfed by this new formation, which is most developed where the membrane is normally most lax, but especially in the bursa-like prolongations, as in that which at the elbow lies behind the humerus, or in the suberural bursa of the knee; indeed, I have seen this latter entirely filled up by the inflammatory growth. The tendinous thecæ in the immediate neighborhood are also frequently occupied by the same material, the tendons becoming adherent to their sheaths. In some cases very close fibrous ankylosis, rapidly becoming bony, is left after a short attack of severely painful inflammation.

After a certain time, the cartilages become inflamed in spots commencing on the free surface and extending gradually deeper; the action is a superabundant cell-growth, whereby the hyaline substance becomes split up into coarse fibres. In other points the structures lose their opalescent appearance and assume a light red color, becoming at the same time very thin. If a section be made, it is found that the thinning does not depend upon wear or loss of surface, but upon encroachment of ossification upon the deep layers. In some places, when the case has been of long duration, this ossification extends all through the thickness of the cartilage, so that next to the joint-cavity lies bone which is bright and polished, usually having a reddish tinge, from vascularity. The bone itself is found on section to be much condensed, every plate of the cancellous structure being abnormally thick, and every cavity small (osteosclerosis). Moreover, the inflammation spreads from the synovial membrane to the periosteum, and produces, by reason of its organizing quality, a number of irregular outgrowths from the bony surface—osteophytes—which considerably deform the neighborhood of the joint, and occasionally present considerable obstacles to movement. The surface of the bone, where not studded with osteophytes, has an unmistakable appearance: the natural elevations and depressions, without any describable alteration in shape, are exaggerated, and the small openings and grooves for vessels are increased, so that the bone, though condensed and heavy, appears porous, especially at those parts where vessels pass. In some cases, a peculiar lengthwise marking gives to the bone a surface looking almost fibrous. Of the other forms, the second appears but a slight and intermittent form of the first; a

¹ I would call especial attention to the characteristic manner in which this tissue, while young, tears in strips with well-marked striation; it is like the sort of tear which takes place in the white matter of a brain that has been a long time in spirit.

certain thickening of the perisynovial and synovial tissues doubtless takes place, but I must confess myself unable to describe the condition from anatomical examination. Patients do not die of this joint trouble, and no opportunity of examining such a joint, only recently affected, has ever occurred to me. The inferences as to morbid anatomy will be given in the description of symptoms. The third condition, which constitutes a form of hydrops articuli, will be described with that disease; here it need only be said that many rheumatic patients suffer from irregularly remittent attacks of slightly painful fluid effusion accompanied by a little thickening; again and again these may occur, and the fluid be reabsorbed, leaving only some laxity of parts behind; but if the attacks come on in very close succession, and last during a considerable time, a sort of mild hydrarthrus, accompanied by considerable joint weakness, will result.

SYMPTOMS OF RHEUMATIC SYNOVITIS.—In a certain point of view, a joint left by acute rheumatism, lame, painful, and often deformed, may be regarded simply as incompletely recovered, even although the general disease be well. The course of events is generally as follows: The attack is severe, the pyrexia considerable, and, after a certain time, debility is strongly marked. Usually, during the fever, a smaller number of joints than is customary in so severe a case, are attacked; but sometimes a goodly number may be affected, the inflammation passing rapidly from one to another. In either event one particular joint, generally a large one and among the earliest affected, remains persistently inflamed amid all the fluctuations and variations of other parts. During the somewhat protracted convalescence, all other joints save this one (sometimes two are thus implicated), get well. After a certain period of frequently pretty severe suffering, pain may cease, and the joint be ankylosed, or, what occasionally happens, it may become subluxated and otherwise distorted.¹ Rarely at this period is there much fluid effusion, but there is a sometimes leathery, sometimes more doughy thickening, filling up all the space between the skin and the bones, obscuring the proper shape of these latter, and giving a peculiar, unmistakable sensation to the hand. This and the history of the rheumatic fever immediately preceding, sufficiently mark the diagnosis of the disease. It may, however, be said that joints cured of such attacks may, after years of health, become affected with hydrarthrus.

But rheumatic joint disease is not always immediately due to the fever; it may originate, when the diathesis is present, in some exposure or slight traumatism, or in both. Under these circumstances the disease, more or less acute, may be continuous, but is often remittent, coming on irregularly at intervals—each attack leaving the joint lame, and in a condition very prone to further disease. Even during the intermissions, the joint is not quite at ease; perhaps a mere stiffness on first rising will be for a time the only inconvenience, but afterwards will follow a certain discomfort in bed, a difficulty in finding a position in which the limb is at ease, and a sensation of half-developed cramp in some of the muscles.² If the diathesis be strongly marked, there are frequently also, at this period, vague and uncertain pains in other limbs. The joint is now a little swollen, with a certain amount of fluid effusion, and the tonic contraction of the muscles is a little lax; at the knee, for instance, the patella floats a little loosely. Movement, particularly after a period of rest, causes

¹ I have now under my care a patient, aged 54, who has suffered a severe attack of acute rheumatism; her right wrist is fixed partly by fibrous ankylosis, partly by tendinous adhesions; her right knee was swollen, and very painful when I first saw it, and was suffering three forms of distortion—subluxation backward, abduction, and outward rotation of tibia.

² At the knee, the biceps is more particularly subject to this sort of pain, chiefly in the tendon where it bounds the popliteal space.

a crackling to be communicated to the hand, of a sort that reminds one of what is heard when sand gets between the teeth. Not unfrequently this crackling is quite audible—a coarse and rough, but not a hard grating. The patient may, after a time, recover, and perhaps permanently; but very often some imprudence in diet, some exposure or over-fatigue, or simply a loss of health, may bring on recurrences which occur again and again, till the patient is obliged to confess to himself that the joint is getting weaker and more painful.

At this time the signs of diathetic influence are sufficiently marked. The patient is distressed, perhaps irritable, never quite free from pain. The temperature rises at night. The tongue is white, perhaps creamy, and marked at the edge by the impress of the teeth. The breath has a faint odor. The urine is very acid, depositing lithate of ammonium, or the red sand (uric acid). The joint itself is somewhat tender and hot, in some cases red; its movements of flexion, and more especially of extension, are limited and painful. Fluctuation, if it can be detected, is rather distant, there being evidently a solid thickening between the wave of fluid and the skin. If there have been but little fluid effusion, or if fluid, previously abundant, have disappeared, crackling is distinct. The shape of the swelling is very characteristic; it is not, especially when there is little excess of fluid, round, like the enlargement of either serous or strumous synovitis, but is angular or square; it is to palpation tough and leathery, and has somewhat abrupt edges; that is to say, in tracing with sufficient pressure the form of the limb from its middle downward, all is normal till the hand, arriving at the neighborhood of the joint, detects distinctly the abrupt edge of the hard, elastic swelling; this is very distinctly felt at the bursal prolongations. By this time the limb-segment above, and, to a less extent, that also below the joint, will have become considerably wasted.

The disease no longer intermits, although it may fluctuate. The muscles, which formerly were somewhat painful and tense, now begin to twitch at night, and those twitchings soon develop into regular starting pains, which often, in this disease, are extremely severe, and are not merely limited to the period of falling asleep. Occasionally a slight movement will bring them on, and at the same time a sort of spasm in the limb, which is very distressing, and which causes a sort of pain in the joint, as though it were being slowly forced asunder. The limb wastes very rapidly, and the cord-like muscles feel hard beneath the skin. Tenderness about the joint is slight, save at a spot a little inside the patella, which often will not bear even slight pressure; and here is the chief seat also of the pain. The heat about the part is considerable; redness is only observed in the earlier stages, but I have constantly observed, in older cases, a peculiar, dark, almost brown, appearance of the skin.

Abnormal mobility is in the late stages very frequent, and is often accompanied by a particularly harsh grating—a smooth but hard crepitus—and sometimes by severe pain and by spasmodic contraction of the flexors.

The more hydropic joint-rheumatism is at its commencement a milder affection, though, if not cured, its later stages lead to very considerable evil. It also begins with fluid effusion, which gives, as a rule, no pain further than a dull aching, with a sense of distension and weakness. If there be any pain at all, it comes on after prolonged exercise or over-fatigue. Perhaps, too, while using the limb, a sharp, quick pain, leaving for some minutes a considerable remnant, may occur. The joint is more rounded than in the other form of rheumatic synovitis. The positions of ligaments and tendons are less distinct than in acute sero-synovitis.¹ Palpation very readily detects fluctuation.

¹ After a certain duration these parts are not designated at all. The joint, more especially in the case of the knee, assumes the shape of a ball.

tuation, which lies very near the hand. If the surgeon, with his finger-tip placed on the most accessible part of the synovial membrane, rub the soft parts with sufficient pressure to and fro, he will feel a peculiar crackling, and when the patient alternately bends and straightens the limb, the surgeon may with the palm detect a similar friction-sign. Both these forms of crepitation are very fine, especially the first. I have named it *silken crepitus*, because it is exactly like what may be obtained by rubbing between the finger and thumb two opposed surfaces of stout silk. At a later period, the crepitation, especially that produced by movement, becomes coarser; afterwards, if the joint get very full, both forms may disappear. But we have now to do merely with early symptoms, and I would direct especial attention to the fact, that, in a large proportion of cases, the surgeon's finger, rubbing the soft parts about the joint up and down, will feel, besides the crackling, a number of little lumps, gliding away under and escaping from the pressure. These are evidently very abundant, very movable, round, or rounded, and not hard. Cases presenting these symptoms will, if not cured, end in one of two ways—either as one of simple *hydrops articuli*, or as one of multiple false bodies with some little effusion. Both of these maladies are discussed in a subsequent portion of this article.

TREATMENT OF RHEUMATIC SYNOVITIS.—If an inflamed joint, after acute rheumatism, comes out of the physician's care into the surgeon's hands, some malposture is very commonly found. In such a case, the severe fever has probably produced such suffering and restlessness that it has been hardly possible to keep the limb on a splint. Thus it is usually the surgeon's first duty to place the limb in a proper position, even though inflammatory symptoms be still pretty strongly marked. This alone, as in other joint-diseases, will very much mitigate the pain, and I have known it to cause the nightly high temperature, appearing at first sight as a remnant of the fever, but in reality due to the joint-inflammation, to decline. If the very slight force which nearly always suffices to place the limb upon a splint, in the proper posture, should produce pain, a small hypodermic injection of morphia near the joint will afford relief.

After this, the limb must be kept in one of the removable splints described in other sections. Blisters are, in my experience, more valuable in this form of synovitis than in any other joint-malady; they should be small, should be allowed to heal quickly, and should be frequently repeated: they¹ are most efficacious, in the case of the knee, when placed over the patellar plexus; and though other points of skin must of course be utilized, most of the blisters should be applied in patches about $1\frac{1}{2}$ inches in diameter, over a hand-wide space above the patella and inside of the rectus tendon. Another remedy whereby counter-irritation, or indeed vesication, may be produced, is the oleate of mercury, first introduced by Mr. Marshall. It is made by rubbing up the yellow oxide of mercury with different proportions of oleic acid, so as to procure a compound of which the mineral salt forms either 5, 10, or 20 per cent.² The stronger preparation will blister most skins if painted on, night and morning, for a day or two; the weaker may be rubbed on with a piece of flannel. We may thus use either one or the other, according as we want a more or less irritant action. The value of this drug is difficult to fix. I certainly have seen cases in which sluggish, hard swelling rapidly diminished under its use; while in other cases, merely the ordi-

¹ One method of treating acute rheumatism, which has been highly extolled, is by frequent blistering.

² The formulæ stand thus: yellow oxide of mercury, gr. v, gr. x, gr. xx, mixed with oleic acid, gr. xcv, gr. xc, gr. lxxx.

nary effect of counter-irritation appeared to follow. A slower local action of mercury may be produced by using, under a compress, for several consecutive nights and days, equal parts of mercurial and iodide of potassium ointments; or, if gout be certainly absent, another part of iodide of lead ointment may be added. Iodide of cadmium is also much extolled, or the iodide of potassium ointment may be used alone. The judgment which I would give as to all these remedies, is that as adjuvants to other means they may be advantageously employed, as long as they are considered as mere aids; but that they should never be used as though they could be of the slightest use without careful mechanical treatment.

In the mean time, such remedies as are useful in rheumatism should be given internally; but the medicinal treatment will fall more naturally into our subject when discussing the remittent form of the disease.

While thus placed, the patient being at rest (in bed if the disease be in the lower limb), careful watch must be kept lest an unnecessary ankylosis, or considerable joint-stiffness, accrue. The ease and rapidity with which rheumatic disease leads to ankylosis must be borne in mind, as also the liability to adhesion of tendons to their sheaths, or to neighboring parts. While pain and tenderness at the special points¹ are present, absolute rest must doubtless be continued; but when these are absent, some change of position, not at first by passive movement, but merely by changing occasionally the angle of the splint, may advantageously be used, while note is taken concerning any increase of pain, or any rise of temperature.

When the inflammatory signs have ceased, or are but very slight, the malady comes into the same category, as far as treatment is concerned, as the slower and more remittent form to which in the description I have given the second place; that is to say, we have to do with a diathesis which marks itself by fits of exacerbation, alternating with intervals of apparently perfect health. It appears to me that such sequences can only be interpreted in one way. The system elaborates, or fails to excrete, or both, a certain constituent which, accumulating, brings on, after a time, these characteristic symptoms; by treatment or otherwise, this constituent (poison, if the word be preferred) is extruded from the body, and the symptoms then cease, leaving mere effects of the disease behind them; then the same sequence of events recurs. We have, therefore, to do with two phases of the malady, the active and the preparatory. In the active stage, the treatment must be very much guided by the condition of the urine and other excreta. In some patients the bowels and liver are evidently much in fault; the alvine evacuations are scanty, and sometimes clay-colored, a condition in which a mercurial purge or alterative, according to the more or less robust powers of the patient, is useful; or if it be designed to use mercury locally, podophyllin or leptandrin may be substituted. But the great guide to medication must be the condition of the urine, and the amount of pyrexia. If the excretion be highly acid, and if it deposit the lithate of ammonium in large quantities, bicarbonate and nitrate of potassium and ammonium are indicated, and, when pyrexia is superadded, these may be administered also as febrifuge remedies; thus of carbonate of ammonium, twenty-five grains, in a fluidounce of water, may be given in an effervescent form with citric acid, twenty grains, in a similar solution; to this may be added, when the fever declines, the wine of colchicum or the iodide of potassium, or both. Or again, if the fever be high, salicylic acid, or the salicylate of sodium may be employed. In the mean time, butchers' meat must be cut off, and, in most cases, all stimulants also; but if this be undesirable, the safest form of stimulus is old and pure whiskey, in a large quantity of water.

¹ See page 424.

Of wines, hock and claret are the least harmful; next to them, still and sound Moselle. The treatment during the intervals is not the least important, its object being to prevent the storing up of the *materies morbi*. This, though hardly feasible in inveterate cases, inherited perhaps through several generations, is far less difficult in a condition acquired by wrong habits of life. Rapid feeding on badly masticated food, excess of stimuli, especially of beer or of sherry, sedentary habits, and study, undertaken immediately after meals, all tend to this condition; and probably more important than the exhibition of any drug, is the rational regulation of the patient's life. For medicines, when the urine is acid and loaded with lithic acid or lithate of ammonium, the potassium neutral salts, and iodide of potassium or ammonium, will be found useful, while some of the saline waters, as those of Vichy, Carlsbad, Kreuznach, and often the Woodhall Spa of Lincolnshire, may be advantageous. Sulphurous waters, as baths, are in some cases very useful, and certain patients have found benefit from baths of artificially sulphurated water. These are easily prepared by pouring over an ounce of sulphur, broken rather small but not powdered, a pint of boiling water, and, after this has stood five minutes, pouring the whole into a bath previously raised to the temperature of from 93° to 97° Fahr. The patient should remain in the bath a quarter of an hour, additional hot water being added if desirable.

There is, however, another form of rheumatism, which is very obstinate, and usually very painful. It is combined with pallor, anæmia, and an alkaline condition of urine, or one which at least tends to alkalinity. In such cases the treatment must be in almost every particular the reverse of that above described. Alkalies, or the neutral vegetable salts, are injurious; while quinine, iron, salicylic acid, and a certain amount of wine—even sometimes champagne or port wine—are beneficial, at least for a certain period. This condition may have been caused by too assiduous and long-continued treatment of the more sthenic form, or may simply be due to rheumatism, combined with the depressing effect of little food, bad air, and over-work. The appearance of phosphates in the urine must be treated on the usual principles of relieving that condition.

In the mean time, as soon as the more pressing symptoms of joint-inflammation have subsided, passive movement and shampooing have great effect in causing the absorption of the deposited fibrine. The friction should be especially directed centrifugally, the object being to induce activity of the absorbents.¹ In carrying out these measures, the tendency to adhesion of tendons to their sheaths must not be forgotten, and the friction must be directed also to those parts. If the disease be of the wrist, each finger and the thumb should be separately moved; or, if of a compound joint, like the elbow, each of the movements—flexion, extension, supination, and pronation—must be attended to. If the acuter stages have passed, and have only produced slight stiffness, the case is very hopeful; but if considerable stiffness be left, the prognosis is less favorable.

GOUTY SYNOVITIS.

Gout is a malady of very protean character and of very variable severity; nor are the troubles which it produces by any means confined to the joints. Its essence, more demonstrable than that of most other diseases, is a blood surcharged with uric acid, which, combined with soda, forms, when dry, a pulverulent, when wet, a pultaceous substance, that from mere excess infiltrates

¹ See p. 436.

various tissues of the body, and among them those of the joints, and preferably the smaller joints. The pathology of the disease, as thus broadly stated, is attractively simple. We have, on one side, the evidence of a redundant material in the blood, which we can crystallize out upon a linen or cotton thread;¹ on the other, we have a thread or fibre of the human body, on which the crystals form. But it is not to be assumed that herewith all that is worth knowing has been learned; many points remain to be elucidated, and more especially of interest to us are the causes of this great accumulation in the blood of the *materies morbi*, for the accumulation may come from excessive production, from deficient excretion, or from both.

Gout is an hereditary disease,² which only exceptionally attacks young people, but usually manifests itself in the descendant, son or grandson, at about the same age as it appeared in the progenitor. It is much more common among men than among women,³ a fact which, although partly due to difference of habits, is not entirely so, since many men, quite as abstemious as women, are subject to the disease. Gout, or tendency to gout, is greatly promoted by a largely nitrogenous diet, and by fermented liquors—especially by such as contain, with the alcohol, a large quantity of grape-sugar. Persons who are exposed to the influence of lead are peculiarly liable to be attacked by gout; and conversely, gouty persons are extremely sensitive to the influence of lead.⁴ There are several forms in which gout may be manifested: by an acute fit, by chronic disease, and by irregular manifestations (non-articular gout), which may affect any structure of the body. All these may be either tonic or atonic.

The early fits of gout attack healthy structures, through which blood containing abnormal quantities of uric acid is circulating. The disease commences nearly always in one of the small joints, and as a very general rule in the first joint of the great toe,⁵ by inflammation of an acute kind, during which the fluid poured into the joint, and that forming the rather considerable œdema, are rendered milky, or rather like

Fig. 598.



Terminal phalanx of great toe; cartilage thickly infiltrated with urate of sodium. (From a preparation in the Museum of the Charing-Cross Hospital.)

chalk and water, by the great admixture of lithate of sodium, whose grittiness may be felt if the liquid be rubbed between the finger and thumb. After a time, when the inflammatory effusion subsides, the lithate is left, either as a half-dry powder or as pasty masses, in the cavities and among the tissues. These masses, when they attain such a size as to be appreciable from the surface, are commonly called chalk-stones or tophi. Owing to the extreme opacity of this substance, it is very difficult to make out its precise histological position. Some of it is, evidently, merely deposited mechanically, wherever a cavity has been filled with the surcharged fluid. Other, generally smaller, portions appear more regularly placed, grouped chiefly

around the cells of such structures as cartilage, tendon, or ligament, all of which are frequently the seat of this deposit, as is less often the bone in the

¹ Garrod, Treatise on Gout, etc., 3d edition, p. 87.

² About 8 cases in every 10 are hereditary.

³ About 2 of every 100 cases are in women.

⁴ I once saw a gentleman who was very gouty, and on whom an ointment containing a very little lead had produced poisonous effects, giving him the blue line on the gums.

⁵ Probably two causes for this preference exist: the distance from the circulating centre and the pressure of the long blood-column, and the considerable stress brought to bear on this joint by the weight of the body. Gouty persons are often obliged to be careful as to their amount of walking, excess beyond a certain distance bringing on an attack of the disease.

immediate neighborhood of the affected joints. It is to be remarked that the deposit has but little affinity towards organs or parts of organs which are very vascular. Thus the cartilages and ligaments are first and most frequently affected; the synovial membrane itself is less often spotted with chalk-stone, and, when it is so, the fringes are very usually spared.

After a time, or in some persons from the very beginning, tophaceous deposits, accompanied by inflammatory phenomena, takes place also in other organs; for instance, very commonly in the pinna and in the subconjunctival tissue of the lower eyelid, where they appear as little white beads, or in bursæ, both deep and subcutaneous. But far more important are the very frequent and grave changes that take place in the kidneys. These occur very early; and it may even be argued that the true cause of gout lies in a functional derangement of those organs, which interferes with the excretion of uric acid. This derangement will be more fully described hereafter, but just now we are only concerned with the anatomical changes. A section of the kidneys shows, in the medullary portion, fine white streaks converging towards the hilus. These consist of deposits of urate of sodium, at first probably in the interior of the tubules, but afterwards between the tubules and extending into the cortical substance, and in advanced cases even to the surface, so as to be visible beneath the capsule. This deposit gradually induces a form of Bright's disease known as the granular contracted kidney, which is accompanied by albuminuria.

Furthermore, we have to consider certain affections not as yet shown to result from the physical deposition of urate of sodium, but certainly due to its presence: such are skin-eruptions—eczema, psoriasis, urticaria, and sometimes erythema—as also peculiar and very possibly similar states of the surface of mucous membranes, causing catarrhal enteritis or gastritis, or a more severe form of intestinal inflammation. Some gouty persons, moreover, are troubled with a peculiar form of chronic bronchitis, culminating occasionally in acute attacks, and leading to stenosis of the smaller bronchi and to emphysema. Another grave lesion is a form of atheroma, with fibrosis of the capillaries, both producing vascular rigidity and tendency to rupture; hence, apoplexy not unfrequently terminates a gouty life. Other functional derangements appear related to the morbid condition of blood, rather as cause than as effect; these are, besides the disturbance in the excretory function of the kidney, above alluded to, a certain turgid and congested condition of the portal system, which gives rise to considerable derangement of digestion, with formation of much acid in the stomach and intestines, sour eructations, and the passage of flatus, together with a depressed and very irritable state of the nervous system.

Mention has been made of deficient excretory power of the kidney. This more especially refers to the elimination of uric acid. It is one of the earliest manifestations, perhaps, with portal congestion, the very earliest manifestation of gout. A healthy man of 150 lbs. weight, should excrete on an average about 8 grains of uric acid, and 620 grains of urea, in the twenty-four hours.¹ Now, in the early stage of gout, that is, some weeks before the first attack, the amount of the former excretion is very much diminished, that of the latter not at all, or hardly at all, affected; afterwards, only slight traces of uric acid, or none, are eliminated, and the excretion of urea is also much diminished, while some albumen begins to show itself in the urine.²

¹ The average amount of urea may be taken at 1 drachm per stone (14 lbs.) of body weight in the twenty-four hours, that of uric acid at from 0.5 to 0.75 grain per stone in the same period; but both these constituents of urine, more especially uric acid, vary very much, according to the exercise taken, and the more or less nitrogenous quality of the ingesta.

² For these peculiarities of the urine, see Garrod, *op. cit.*; Lehmann, *Phys. Chemie*; and Bartel, *Symptomatologie der Nierenkrankheiten*.

Hence, it may be surmised (not concluded) that the *causa morbi* lies in a certain vice of the nutrient functions, including the dissolution and removal of effete tissues, whereby uric acid is formed in superabundance, or is not converted by further chemical changes into some more easily eliminated material; and that the blood thus surcharged acts injuriously on the kidneys, retarding or preventing the secretion of the substance in question so as to still further increase the saturation of the blood, and ultimately rendering those organs not merely functionally, but organically diseased.

SYMPTOMS.—The form of gout with which only we have to do here is the articular.¹ It has several varieties: acute, sthenic gout, commonly called a fit of the gout; asthenic gout, the fits of which are more commonly subacute; chronic gout, which commonly means the condition left by the acute fit, added to a certain amount of inflammation, and occasionally varied by an acute attack; and simple goutiness, viz., a more or less crippled, non-inflammatory condition of the parts in which the deposit has taken place. It is unusual that a patient should, without having had at least one acute attack, suffer from articular gout and chalk-stone deposit.

The first fit of *sthenic gout* may be taken in practice as the starting-point of the disease; although, from what has been said, it is evident that for a considerable period previous, the excess of uric acid in the system has been preparing. The patient may feel and seem to others to be in good, and even in uncommonly good health, taking food with unusual relish, and perhaps in unusual quantity; or it may be that a certain irritability of temper is observed; or again, he may be unwontedly disposed to fall asleep after dinner—the bowels being at the time a little constipated. Some night, after falling asleep with ease and readiness, he wakes about two or three o'clock with pain in the ball of the great toe; a sense of heat and bursting that in a little time becomes intolerable. On examination, the part is found to be of a deep red, with sometimes a tinge of purple, in which full turgid veins are strongly marked. Œdema causes considerable swelling, and is often more extensive than the redness; the skin is tense and shiny. The toe and its surroundings are extremely tender. As daylight comes on, the pain and the objective signs begin to diminish, and, perhaps, during the day may so far disappear that the patient thinks he has escaped with the fright; even though some pain return in the evening, he may, if still a novice, go to bed with happy assurance; but scarcely has he shaken himself into place before a sharp throb tells him that the enemy is upon him, and forebodes another night of what amounts to torture; and so on through a succession of nights until the fit passes, again, however, to recur at intervals of from four to six months. Each of these fits is accompanied by a certain degree of pyrexia, the rise of thermometer preceding, according to my observation, the pain; the skin is hot and dry; the urine very scanty and high colored. After the attack, all the part that has been inflamed desquamates, not in small furfuraceous scales, but in large flakes.

The early attacks, unless unusually prolonged and severe, leave but little local mischief behind them; but each succeeding one produces more and more injury, and the intervals, therefore, are less free. As a compensation, a joint which has been attacked once or twice, is less painful during the fit than it was at first; other joints are, however, liable to become affected.

Asthenic gout is, if we take typical cases of each form of the disease, very

¹ It is nevertheless essential for the surgeon to know that gout may attack other, especially internal, organs, when the disease may become exceedingly dangerous. If this occur alone, and without simultaneous or immediately preceding joint-affection, it is termed misplaced, aberrant, or non-articular gout; if it arise during an attack of articular gout, which then subsides—a species of metastasis—it is called retrocedent gout.

different from that above pictured; the attack is both less sudden and less severe, the patient feeling a gradually increasing pain, which is never violent; the redness may be a mere blush; the veins are hardly turgid, and the œdema, if any, is slight and deep; pyrexia is hardly marked; but the patient is much depressed in spirit, and low in health.¹ Unfortunately, these attacks are followed by greater injury to the part, and the intervals are less free, than in the other form; other and larger joints also become more speedily involved.

Chronic gout is the condition which exists during the intervals between the fits. In these intervals, the patient is, in different cases and in the various stages of the disease, more or less relieved; but it is only after the first fit or two of *sthenic gout* that he feels quite free from the malady. After many attacks, more or less trouble is continuous. When a certain amount of deposit has taken place, its presence always keeps up a certain degree of pain and a certain amount of inflammation, which augments the injury already done. In a few instances, chiefly of *asthenic gout*, this state continues uninterruptedly; most persons, however, suffer from periodical exacerbations; and during intervals of either comparative quiescence or moderated fit, fresh joints, tendinous sheaths, or bursæ, may become involved; also, and this is of especial importance, it is during this sort of diseased action that gouty degenerations, such as are found in the vascular coats, chiefly occur.

After several fits of gout, or after a considerable period of the more quiet form of suffering, great accumulations of chalk-stone are found, as well in the joints as in the sheaths and bursæ.

I have seen the end of the first metatarsal bone, and the corresponding part of the phalanx of the great toe, so completely occupied that they seemed converted into urate of sodium, with sparse trabeculæ of osseous matter running through them; and the sheaths of tendons, both at the ankle and wrist, with the bursæ over the olecranon processes, and several others, merely bags of chalk-stone. Both hands were grotesquely padded and swollen, with irregular lumps, so that they looked like bunches of badly grown horse-radish.

Attacks of misplaced or of metastatic gout are dangerous according to the vital importance of the organ involved; they frequently observe, in both the acute and chronic forms, a sort of alternation with the joint affection—while the one is severe, the other will be slight, and *vice versa*; the non-articular form is sometimes called “suppressed.” These internal affections interest us only in a secondary manner.² I need only mention gouty encephalitis and cephalalgia, sometimes delirium, and rarely mania, cardialgia and angina, syncope, bronchitis and asthma, gastritis, gastralgia and enteritis, as also the affections of the skin already named, to show (and there are several others) how many and how varied may be the maladies produced.



Fig. 599.

Hand beset with urate-of-sodium deposits. From a preparation in the Museum of the Charing-Cross Hospital.

¹ Sometimes it is difficult to diagnose these cases; considerable help may be obtained by observing the subsequent desquamation, which very usually follows, but not so constantly as after a *sthenic* attack.

² They are only mentioned here, since certain modes of treating articular gout occasionally produce retrocession.

TREATMENT.—The treatment of gout must vary according to its stage, whether acute or chronic, and both forms of treatment must be modified according to the more sthenic or more debilitated condition of the patient. A fit of acute, sthenic gout, especially if such attacks have not frequently recurred, may be treated with a saline purgative, combined with twenty or thirty minims of the wine of colchicum, or, if the skin show any icteroid tinge, the draught may be preceded for two hours by a mercurial, such as gray powder, blue pill, or even calomel, if the discoloration be well marked and the bodily power considerable. It not unfrequently happens that just before being seen, the patient, previously suffering comparatively slight and vague pains, will have eaten a full meal, after which the attack may have culminated. In such a case, the safest and most efficacious remedy is an immediate emetic of potassio-tartrate of antimony and ipecacuanha wine, followed, when the stomach has sufficiently reposed, by a smaller dose of the purgative. At this time, at all events, opiates should be avoided, as they diminish the action of the kidneys; but if the pain be violent, a small dose of the compound ipecacuanha powder may be given, or a quarter of a grain of morphia may be injected under the skin. I have, however, often found that

Potassii bromidi	gr. xx.
Liq. atropiæ salicylatis	℥ x.

acts as an excellent anodyne, procures sleep, and enables us to avoid the evils of opium or its alkaloid.¹ Chloral, though valuable in mere restlessness, is powerless against pain. When the fever is high, and the local inflammation considerable, the tincture of aconite, in the dose of one minim every hour or every two hours, has often, in my hands, proved very beneficial. In less severe cases so powerful a drug may be avoided. By the patient's side, or in charge of his attendant, should be left some doses of the effervescing citrate of potassium, of which, with plenty of water, he may drink freely during the night; it will not merely slake thirst, but will act on the kidneys and on the skin.

For the next few days somewhat similar treatment must be continued; colchicum should as much as possible be spared, since it certainly has a tendency to provoke or hasten recurrence; yet when the pain is violent and of a peculiar "bursting" character, it may be impossible to avoid its use altogether; ten minims twice during the day, and at bedtime, unless violent pain recur, when the last dose may be doubled, should fully suffice. It may be given with the effervescing citrate of potassium, with bicarbonate of potassium, or if one have faith in them, with the preparations of lithium. The bowels should be kept freely open with salines, and plenty of fluid should be taken.

In the mean time food must be limited almost entirely to bread-stuffs and milk; all wines and beer must be strictly forbidden, but if digestion will not go on comfortably without some stimulant, a little old whiskey in some effervescing water may be allowed. In a few days more, when the urgency of the attack and the fever are abating, or from the first if the patient be feeble, some light fish may be added to this diet.

The *local treatment* during this time must be guided by the sthenic or asthenic condition of the patient, and by the amount of inflammation. With some very strong persons much relief is obtained by the application of from two to four leeches over the inflamed joint. In feebler persons, a blister

¹ The liquor atropiæ salicylatis is thus made: Take of atropia 5 grains, and of salicylic acid 7½ grains, rub the atropia to a very fine powder, and then little by little rub with it the salicylic acid. Add slowly 10 fluidounces of hot, distilled water. The whole must dissolve, and the solution must measure, or be filled up to, ten fluidounces.

about the size of a shilling, is more efficacious; it withdraws with the serum a good deal of the urate of sodium. The part should be kept warm; cold, though it often for the time may seem grateful, prolongs and aggravates the attack, and may even be dangerous by causing the inflammation to recede to some internal organ (retrocedent gout). Therefore the part should be wrapped in light cloths, wrung out of a hot solution of bicarbonate of potassium (gr. x-℥j), to which may be added some extract of belladonna or tincture of opium. Or absorbent cotton-wool, into which some strong spirit of camphor has been shaken, may cover the part, and generally the tenderness is such that the weight of the bedclothes must be supported on a bed-cradle.

The treatment of gout in the *intervals of attack* must depend on its sthenic or asthenic quality. In the former variety, food and drink must be limited, and especially the nitrogenous elements kept very low; stimulants, as far as possible, should be avoided, or, if some must be given, it should be old, pure whiskey, or gin, largely diluted. The kidneys should be encouraged to free action, but not stimulated—an indication which I have found best fulfilled by digitalis; the action of the skin also must be aided—an occasional hot-air bath is often useful. Of great importance is proper regulation of the bowels and liver; this, no doubt, may be effected by colchicum in proper combination; but, as pointed out a short time ago, the drug has certain disadvantages. Some practitioners give a hydragogue cathartic every morning, and with certain strong constitutions this may be advantageous; but it does not prevent the tendency to portal congestion. I have found the resin of podophyllum, in $\frac{1}{10}$ grain doses, very useful for this purpose.¹ If more purgation be desirable, the saline purge can still be given occasionally before breakfast. The patient should be encouraged to drink freely of alkaline waters, which are most easily taken in their effervescent forms.

Atonic gout is more difficult of management, and must be more closely watched, as the possibility of lead poisoning, or of serious renal disease, must not be overlooked, while at the same time aberrant forms of the malady are more common in this than in sthenic gout. The treatment may be more tonic; a full diet, and a certain amount of claret or of hock may be allowed; the vegetable bitters, bark, or quinine, and even the lighter forms of iron may be given. With these, some bicarbonate of potassium or ammonium, or the iodide of potassium may be combined, especially if lead poisoning be suspected. But in the meanwhile the sufficiency of the excreta must be maintained. Ash-leaf tea, so highly recommended by certain writers, is both a bitter and a diuretic, but is void of any specific or very potent action in gout.

Certain natural alkaline waters and baths are frequently very valuable in either form of gout. Vichy, Aix-la-Chapelle, Baden-baden (especially the lithia spring), and Carlsbad waters are probably most useful in sthenic, but may, if used only for a short time, also benefit asthenic gout. Afterwards, a stay at some of the more slightly charged springs, such as Wildbad, Toplitz, Gastein, Bath, or Buxton, will probably be desirable. In the atonic form it will generally be desirable to begin with these latter, and to end with any of the lighter ferruginous spas—Schwalbach Spa, Tunbridge Wells, etc. The stronger springs of the Pyrenees are only suitable to cases of very marked debility.

¹ The formula which I employ is this: Podophylli res. gr. j; Tinct. zingiberis, ℥j; Spt. vini rectificat. ℥j. A teaspoonful in water, twice or thrice a day.

HYDROPS ARTICULI, HYDRARTHROSIS, OR HYDRARTHROSIS.

The names above given are derived simply from a symptom which accompanies several forms of malady, and therefore these terms include more than one kind of disease. We have to do with an increased effusion into the joint, which (1) originates in a demonstrable inflammatory attack; (2) begins without demonstrable inflammation and continues without further change than the thickening caused by the presence of the fluid; or (3) is accompanied or caused by great hypertrophy of the fringes (rheumatic hydrarthrosis).

Many cases of joint-dropsy follow immediately, others more remotely, after acute synovitis; and in some of these cases there is strong reason to believe that a fibrinous concretion, left behind, has become adherent to some point of the synovial membrane. Clinically, this idea may be confirmed by observing, in the early part of the case, that the patient refers a frequent and sharp pain to a certain spot which is not commonly the seat of such sensation.¹ Of course, however, in many of these cases there is no sign, no reason to suspect the presence of such a body. The inflammation, whether it have been more or less antecedent, appears to have changed the secreting or the absorbing functions of the synovial membrane, producing a congestion, often extremely well-marked after death, either general or in patches; the latter, I believe, more usual, except in old cases. Mere congestion, produced by venous obstruction higher up the limb, never produces hydrarthrosis. Passive œdema, either as in general anasarca, or as that caused by pressure on the femoral vein from aneurism, spares the joints. Even though the limb be swollen almost to the point of bursting, no excess of fluid occupies the synovial cavity.

PATHOLOGICAL ANATOMY.—I have had the opportunity of making examinations in several cases of this affection: one after fifteen months during which the lad had been quiescent, the case having begun in an acute synovitis, and others after four and more than seven years of chronic disease respectively; in both cases, of course, an abnormal amount of fluid was found in the joint. Besides this, there was in the former considerable redness of the whole synovial membrane, very marked in the folds on each side of the patella; but in one point of the subcrural sac was a spot of extreme hyperæmia. The fringes, especially round the patella, were a little more evident than usual; and hanging by a narrow stalk from the crucial ligaments, was a little hygroma. The cartilages were milky, sodden, and a little soft. I look upon the patch of excessive congestion in the subcrural prolongation as having been probably the cause of the hypersecretion, and upon the other changes as secondary.

In examining the other cases, which from the first were chronic and non-inflammatory, I found a remarkable condition of synovial membrane. The fluid in the joints was very yellow, albuminous, lubricating, but not thready. The cut edge of the synovial membrane exhibited a yellow pulp not unlike that of an over-ripe orange; in the older case this was, where most developed, $1\frac{1}{2}$ inch, and in the more recent $\frac{3}{4}$ inch thick. It was soaked in, and possibly derived its color from, a similar fluid to that in the cavity; in its substance were a great number of little chambers communicating freely with one another, and varying from a microscopic size to such as would contain a No. 4 shot. The inner surface was composed of rounded or conical eminences

¹ It would seem that such a concretion, either by exercising a certain traction on the point of attachment, or otherwise, may produce a congestion or distension of vessels favorable to the effusion of much fluid. A mere soft, lipomatous, false body will have the same effect, the disease proving incurable till the growth is removed.

projecting from $\frac{1}{8}$ to $\frac{1}{4}$ inch, with about similar diameter, and placed close together. This mass was surrounded by a dense bluish-white capsule, looking like condensed fascia or tendon; it was thicker in some parts than in others, averaging $\frac{1}{8}$ inch. There were no external ligaments save this capsule; the crucial ligaments were much elongated and loose; the cartilages, nowhere ulcerated, were fibrous almost throughout.

Microscopically, the pulpy mass consisted of a wide-meshed areolar tissue, composed almost entirely of yellow elements. The loculi were partially lined by endothelial cells. In one case there was no appearance of a hypertrophied fringe; in the other there were two, not dendritic, but formed of lumps about the size of horse-beans, pedunculated and attached to the synovial membrane by thin stalks.

We are thus forced to the conclusion that mere passive congestion from venous obstruction does not produce hydrarthrus—that, in other words, it is not, properly speaking, a dropsy—but that a capillary, active hyperæmia is the efficient cause; that in cases following acute sero-synovitis, this vascular condition is probably localized in one or more spots of the synovial membrane; while, when the disease is from the commencement chronic and non-inflammatory, the hyperæmia is more general, and tends, together with the effect of soakage, to a peculiar hypertrophy of endothelium, and of the immediately subjacent layer of the tissue—of the synovial *intima*.

But a different condition obtains when the local malady, commencing or not after an acute synovitis, is mingled with the influence of a rheumatic diathesis, sufficiently strongly marked. In such cases the hyperæmia exercises its more strongly formative power in the production of very greatly hypertrophied fringes. These organs, developed for the purpose of increasing the surface for secretion, have, in this disease, their function exaggerated, with the effect of producing excessive secretion. In the beginning, the malady is a chronic rheumatic synovitis (page 436), but it more or less rapidly assumes activity both of secretion and of fringe-growth, and certain cases of

Fig. 600.



Fig. 601.



Excessive fringe-growth of hydrarthrosis.

The same, under a powerful single lens.

that disease become the most obstinate examples of hydrarthrus. In this variety, the synovial membrane is chiefly remarkable for the shaggy condition of its internal surface, which looks as though covered with lichen, or which may be compared to the outer surface of the foetal chorion. The villi,

as the hypertrophied fringes have now become, are variously formed and constituted in different cases. They are branched and ramified in all directions; but in some instances the twigs end in simple blunt points, in others they are bulbous, and in others beaded, giving the fringe a form like a bunch of currants. The bulbs or beads may be simply bags of fluid, or collections of fat, fibrous tissue, fibro-cartilage, true cartilage, or bone. The fringes, not remarkably vascular, contain each an artery and vein; the twigs are without such vessels, or possess only short branches, which terminate long before reaching their ends.

Occasionally, in such cases, the fluid contains a variable, sometimes an immense number of free concretions—the hydatiform bodies of Dupuytren; they are gelatiniform, yellow, and transparent, and, if numerous, very small—about the size of a pin's head or less. If only few in number, they are generally much larger.

The synovial and perisynovial tissues, thickened, soft, and sodden, are surrounded by a tough, firm capsule, developed in consequence of the pressure from within. In old cases this is sometimes so firm that even after withdrawing the fluid, in anatomical examination, the empty sac does not collapse. Moreover, this tendon-like capsule may be in places distinctly cartilaginous, plates of cartilage having been developed in the fibrous substance, or almost the whole tissue having undergone such a metamorphosis.

This latter form of disease is evidently related to cases of multiple false bodies in the joint-sac, and thereby to arthritis deformans; and we shall hereafter perceive that it is impossible to draw any sharp line of distinction to mark a point where the one malady may cease, or the other may begin. In many cases of hydrarthrus, after the fluid has been withdrawn, a number of these bodies may be felt; and again, in certain cases of single loose cartilage, the accompanying hypersecretion ceases after removal of the loose body.

SYMPTOMS.—Hydrarthrus rarely affects youth, and is more common after than before forty-five years of age. Its history may be either that of a gradual, painless increase of size, or it may have begun with an injury, followed by acute synovitis, and by more or less painful sequelæ. The histories being thus dissimilar, are of little aid to diagnosis, which, however, presents but slight difficulty, the essential feature of the disease being a large fluid effusion in the articular cavity, without any sign of inflammation, or at least of active inflammation. The signs and symptoms of fluid in the different joint-cavities have already been detailed (p. 381); but the greater quantity of fluid and its slow accumulation permit of more distension of opposing parts, and thus the locality of ligaments, tendons, etc., is little marked, while certain portions enlarge to an incommensurate degree. Thus at the *knee* (the most common site of this disease), the suberural portion of the sac is more particularly distended; this is most visible when the patient stands erect. There is also considerable enlargement on each side of the patellar tendon. The synovial membrane, too, often bulges into the popliteal space, which then is no longer hollow, but prominent. Very often, at the *elbow*, the membrane is protruded through one of the openings in the posterior ligament, forming a bursa-like enlargement, usually in the immediate vicinity of a condyle. The chief swelling is about the inner condyle, where the fluid in many cases produces a large ovoid protuberance; the part of the sac that underlies the triceps is also considerably enlarged. Hydrarthrus of the *shoulder* has been observed by M. Roux and by myself. In my case the patient had almost lost the power of lifting the arm from the side; it measured, as it hung, half an inch more

than its fellow; by lifting the limb sharply upward from the elbow, one could feel the head of the humerus impinge against the glenoid cavity, and the arm lost its abnormal length. The swelling was very peculiar; the cavity of the axilla was nearly filled up. The deltoid portion of the shoulder was very large, more especially at the anterior and posterior part. Behind, the fluid tumefaction occupied the outer half of the infra-spinous fossa. On the top of the swelling the acromion seemed to form a depression, more especially visible when the arm was pushed upward, as above described. Of course, in all these cases fluctuation from one part of the tumor to the other is very distinct. When distension from within, by fluid accumulation, has gone on for a considerable period, the ligaments and other fibrous tissues about the joint become considerably lengthened; they no longer bind the bones firmly together, and the use of the limb is much impaired; the tibia or ulna may in such cases be rotated, abducted and adducted, or made to glide sideways on the femur and humerus respectively.

Fig. 602.



Simple hydrarthrosis of knee; distension of subcutaneous sac; bursiform enlargement laid open behind.

DIAGNOSIS AND PROGNOSIS.—The mere detection of a non-inflammatory accumulation of fluid in the joint, easy as it is, gives us the diagnosis of hydrarthrosis; but in order to form a probable prognosis, we must distinguish the one sort of case from the other.

While distension of the joint-sac is still moderate, we may, by pressing deeply on its most accessible part, obtain, if there be fringe-hypertrophy, that gentle, soft crepitation which I have described as "silken crepitus," which will be of finer or coarser quality according to the smaller or larger size of the growths. Sometimes, in verifying fluctuation, the hand will feel, as the wave passes from place to place, a sense of the movement, the actual current; this cannot of course be due to the motion of a pure fluid; it is caused by the passage under the fingers of those little semi-solids already mentioned (melon-seed bodies). But when the sac is completely full, these peculiarities cannot be felt until it be partially or entirely emptied. In the latter condition, we may also detect any nodular terminations to the fringes that may be present. Also, but best when the joint is half empty, any plates of cartilage or other substance developed in the joint-tissues can be made out; they are to be felt as harder portions floating on the subjacent fluid, and slightly elevated beyond the surrounding structures; they can be depressed towards the cavity, but cannot be moved from side to side, and cannot be so isolated as to be grasped in the fingers.

The prognosis depends very much on the presence or absence of fringes, nodules, and extra-articular plates; it is unfavorable when the two latter can be felt, but is less bad when only fine fringe-hypertrophy is present. When no sign of internal roughness or of plates can be felt, the prognosis, though guarded, may be fairly favorable, unless the disease be old, abnormal mobility free, or the constitution broken either by age or marked diathesis.

TREATMENT.—Unless very unmistakable signs of vicious diathesis be present, any systemic treatment of hydrarthrus is nugatory; no amount of purging or diuresis will, in any appreciable degree, affect the disease. Rest in bed often has a marked effect in reducing the swelling, especially if the case be recent, and if the patient has previously been freely walking about. In all cases, especially if pain exist, the limb should be splinted. Also, in recent attacks, pressure, by means of an elastic-webbing bandage, is beneficial, and may even be curative; the parts below must be supported by a firm linen or cotton bandage, to prevent swelling. Iodide of potassium or of lead may be applied under the bandage, and I believe myself to have seen good effects from such treatment. It must always be remembered that these milder methods may appear while the patient remains in bed to have been perfectly successful; but the surgeon must be careful not to encourage false hopes, for it not unfrequently happens that as soon as movement recommences the disease returns.

Evacuation by puncture or aspiration is a most valuable resource. Care must be taken to avoid the entrance of air, as already described (see page 388). As soon as all the fluid has been drawn off, an elastic-webbing band should be firmly applied, the limb being supported on a splint. In more than one case—notably that of a medical man, who had been for five years almost incapacitated from going about—I have succeeded in curing the disease by these simple means. Sometimes it happens that the fluid will not flow through the fine canula used for evacuation, but sometimes, in spite of such failure, the subsequent pressure has been quite successful; I suppose because the fluid has been slowly squeezed out into the surrounding tissues. If this result do not occur, or even at once, when no flow takes place, a tenotome may be passed into the same opening, and a large incision made beneath the skin in the synovial membrane. If the tumefaction be great, this may be practised on both sides of the joint, and afterwards the pressure applied; in doing which it is well to endeavor to get one edge of the divided synovial membrane to overlap the other.

If evacuation through the trocar have been practised with temporary success, but with subsequent recurrence of the disease, injection of some irritant substance may be employed. The best of these is doubtless iodine; one or even two fluidrachms of the tincture of iodine in the fluidounce of distilled water may be employed. The fluid from the joint should be measured, and, all appurtenances being at hand, a like amount of the solution should be mixed, and at once gently injected through the canula; a little force may, towards the termination of the injection, be used to induce the full quantity of fluid to enter, but sometimes this is impossible. When the injection is completed, the joint may be gently kneaded (the canula being occluded), and the limb raised and turned on the side, but without moving the joint, to insure, as far as possible, contact of the liquid with all parts of the cavity. As soon as a certain sense of heat in the part, together with a dull aching up the limb, is experienced, the canula-mouth should be opened and the solution allowed to flow; it should then be gently pressed out of the cavity, either by the hand or, better still, by an elastic bandage.

Free incision appears a very heroic method, but by proper precautions, using either carbolic acid or boro-glyceride, is in reality very safe, and is no doubt exceedingly efficacious, especially when fringe-hypertrophy or melon-seed bodies exist. But the incision must be really free, not a mere little cut. If it have been made over a place where the silken crepitus gives evidence of fringe-hypertrophy, one or more of the growths will probably float out, and may be removed, which is best done by twisting. I have on more than one occasion passed my finger into the joint, brought enlarged fringes

to the surface, and removed them. Afterwards, a tube is passed just within the cavity, and a strong stream of some aseptic fluid injected. I think carbolic acid is best for this purpose, as its stimulating effect is valuable. The tube is to be retained, and the joint dressed antiseptically (by this I do not mean of necessity by Lister's method), placed on a splint, and left for two or three days, when it may be again washed out. The irrigation is to be continued every other day, at least until the wound is nearly healed; the drainage-tube is to be gradually shortened and ultimately discontinued.

This last method is the best and most certain means of treating large hydrarthrus with much fringe hypertrophy. It must, however, be employed with great caution; the temperature, and the condition of the system and of the joint being constantly watched.

MOVABLE BODIES IN JOINTS.

The singular bodies which sometimes exist, and which enjoy free or partially free mobility, within articular cavities, are very various in number, size, shape, constitution, and genesis, while in choice of locality they are far less capricious. They have indeed so strong a predilection for the knee-joint, that I estimate from collected cases 85 per cent. to occur in that articulation; the next most common seat is the elbow. Movable bodies occur, but rarely, in the hip and in the lower jaw. Sir Charles Bell found one in the ankle, and one has been seen in the wrist.

There may be only one such body in the joint-sac, or there may be vast numbers; in the former case, or when they amount only to three or four, they attain to a measurable and perceptible size; in the latter they are very minute, smaller than a grain of mustard seed.

If we except a certain irregularly formed class (detached but normal portions of the joint), we may classify them according to shape into four categories: 1. Oval or circular plates, bi-concave, bi-convex, or concavo-convex. 2. Globular, ovoid, or chestnut-shaped. 3. Conglobate, or mulberry. 4. Pyriform.

The constitution of loose bodies may be either cartilaginous,¹ bony, mixed bony and cartilaginous, fibrinous, or lipomatous.

Their genesis is even more variable than their structure.

(1.) They are formed from hypertrophied fringes, more especially from those prolongations which Rainey² has so carefully described as secondary sacculi; each villus of a fringe consists of a small projection carrying an afferent and an efferent vessel; from some of these hang, by thin stalks, very small, extra-vascular sacculi containing synovial fluid. When hypertrophy of fringes takes place, these sacculi enlarge; some become vascular, and simply form part of the dendritic growth, but in others hypertrophy leads to new development; cartilage-cells are deposited; the sacculi become nodules which grow while the stalks connecting them to the wall of the sac continue entire, and perhaps even longer. These, however, after a time break away, and the masses become free. By this means are formed many single and most of the multiple false bodies—those which are found in old rheumatic cases, and those which are an early manifestation of arthritis deformans. Lipomatous bodies, when two or three in number, are of like origin, as are also multiple lipomata, and among these I include that rare and singular condition called by Volkmann *lipoma arborescens articulorum*.³

¹ In the first recorded case (A. Paré, 1558), the body was a cartilage; hence, movable bodies have commonly been called loose cartilages.

² Pathological Transactions, vol. ii. p. 110.

³ Pitha und Billroth, Handbuch der Chirurgie, Bd. ii. Abth. ii. S. 576.

(2.) By metamorphosis of some part of the peri-synovial tissue through inflammatory or hyperplastic changes. Under the influence of some slight injury, or of a strongly marked dyscrasia, an inflammatory thickening or a clot of blood is deposited in the fine tissue just outside the synovial *intima*. Instead of being absorbed, this forms the nucleus of fresh growth; then a few cartilage-cells are deposited, and they, gathering hyaline material around them, cause further increase, until a little meniscus or plate is formed,¹ which by the unyielding quality of the capsule and ligaments, and by the action of contracting muscles, is pressed inward, and bulges a little into the joint cavity, pushing before it the synovial membrane. Increase in size exposes the body to still more pressure from without; it, therefore, intrudes, still with the synovial covering, more and more into the cavity, until it lies quite within it, but still attached by a fold of synovial structure, which also, until worn away, surrounds it after the manner of a mesentery. When thus far intruded, it comes also within the influence of the joint movements, which, moving it from place to place, drag upon the fold, elongate, and attenuate it until it at last breaks away. Bodies thus formed are meniscuses, either of cartilage or of bone; more rarely a lipoma, formed in the subsynovial tissue, becomes intruded into the joint in a similar manner; such intra-articular lipomata are solitary or in pairs. I removed a few years ago a pair of such fatty bodies; they had arisen one on each side of the *ligamentum patellæ*.

(3.) Another mode of formation is mechanically similar, but occurs under widely different circumstances. We have seen how in fully developed, rheumatic, but subacute, joint-inflammations, osteophytes are formed, and especially at the line where the synovial membrane is attached to the bone; we shall hereafter find that a similar but a more redundant hyperplasia takes place also in arthritis deformans. Sometimes the formative action extends from this locality to the periarticular tissues, certain spots of which become cartilaginous and bony; when that takes place, the same mechanical influences which are above described as forcing meniscuses of cartilage into the joint, thrust not unfrequently the osteophytic productions into the joint-cavity. Such is usually the genesis of irregular and conglobate bodies; they are sometimes pure cartilage, sometimes bone, more often mixed.

(4.) John Hunter ascribed the origin of loose bodies to blood-clots or fibrin-clots formed in the joint at some antecedent period. This method of formation is, however, uncommon; it is evident that it can only take place after injury, or after an attack of acute synovitis. Probably, after such events, only those clots which remain or become adherent can undergo metamorphosis into another tissue. Especially must it be remarked here that occasionally, years after the removal of one false body, several others form. These probably originate in bleeding from the operation wound into the cavity, but they may also be produced by an irritation of the wound, setting up local fringe-hypertrophy, or cartilage-formation primarily extra-articular.

(5.) Ecchondrosis, that is, direct growth of a cartilaginous pedunculated tumor from an articular cartilage, is a very rare event;² its etiology is entirely unknown.

(6.) Certain loose bodies have been proved to be portions of normal cartilage broken loose from their attachment. They may come from an interarticular

¹ A case by Mr. Shaw (Pathol. Trans., vol. vi. p. 328) illustrates in a most instructive manner this mode of formation. The body producing the primary irritation around which a cartilaginous mass gathered, was not, in this instance, a blood-clot, but a needle which had at some former epoch been thrust into the limb, and which lay for a time close to the joint.

² Unless, as I am disinclined to do, we take the early cartilaginous stage of an osteophyte for an ecchondrosis.

meniscus,¹ or from an articular cartilage previously healthy,² or, as Mr. Teale³ and more recently Sir J. Paget⁴ have pointed out, a certain district of cartilage may die by a process of "quiet necrosis," slowly become detached without suppuration from the underlying bone, and then break away from its lateral surroundings and be shed into the joint.

The above descriptions indicate that certain cases are in their origin a part of a diathetic disease, an outcome of grave changes in the joint-structure, a form of rheumatic synovitis, of arthritis deformans, or sometimes of obscure disease affecting all the articular tissues, generally traumatic in origin; in other cases, one or more false bodies are accidental occurrences, if such a term may be used; they arise, at all events, without the accompaniment of any severe or demonstrable malady, from a fortuitous deposit in the perisynovial tissue of a blood-clot, or of fibrin, or from enlargement of a single fringe-villus, which afterwards is excited to additional growth by the joint movements, or perhaps by being pinched between the bones. The mere presence of a smooth, hard, or soft body in the joint-sac is not necessarily productive of disease, particularly if it be quite free; but bodies which remain attached, by constantly dragging on the pedicle—and even sometimes such as are quite detached—often set up an irritation which tends to the production of hydrarthrus. Moreover, a distressing accident is very liable to occur, namely, intrusion of the loose body between the articular surfaces, or other sufficiently tense part of the joint; this produces intense pain, and is very generally followed by a smart synovitis, which, if frequently recurrent, will shortly be very detrimental to the integrity of the part.

SYMPTOMS.—A disease whose etiology varies as much as that in question, or rather, it might be said, a condition which may arise from such very different diseases, can hardly present a homogeneous set of symptoms. But since those maladies of which the presence of false bodies is a part, possess certain well-marked characteristics of their own, we need here do little more than mention them. The tendency of subacute rheumatic synovitis to form multiple false bodies has already been mentioned, and the method whereby these may generally be detected has been described; and further consideration will be given hereafter to the bodies connected with the earlier period of arthritis deformans. Painless, or nearly painless, persistent, fluid effusion should always lead to the suspicion that false bodies, one or more, may be in the joint. Of course, these can only be detected by physical examination when the joint is not greatly distended, or when it has been partially emptied. But the presence of a solitary false body, or of a small number of false bodies, may remain entirely unknown until discovered by accident. The patient, believing that he is entirely sound, may by chance feel with his fingers that there is in one of his joints—generally the knee, less often the elbow—a very mobile little lump, which as soon as it is touched glides away like a frightened mouse into its hole (joint-mouse, "Gelenkmaus," the Germans call it), and it may be days before he finds it again.

More often the patient discovers the loose cartilage in a far more unpleasant manner. Thus, while walking, unconscious of any disease, still less of danger, he may be suddenly seized by a pain so severe that he turns sick and faint. Unless some support to which he can cling be at hand, he falls. The joint being fixed by spasm of the muscles, the pain gradually relaxes, and at the same time comes a feeling that if he could only bend, or otherwise

¹ See a case by Mr. Brodhurst. *Path. Trans.*, vol. xviii. p. 214.

² See Klein's case in *Virchow's Archiv*, Band xxix. Heft 1 und 2.

³ *Med.-Chir. Trans.*, vol. xxxix.

⁴ *St. Bartholomew's Hospital Reports*, vol. vi.

change the posture of the limb, he would be relieved; and if he be bold and fortunate, this really happens; but sometimes such movement is, or seems, impossible. The patient has to be taken home; perhaps a surgeon moves the joint, and at once relieves him; or he goes to bed unrelieved, and, if he fall asleep, probably wakes in the morning to find that nothing is left of his trouble but a little aching, and perhaps some swelling of the joint.¹ This sort of attack is attributed to the body having intruded between the joint surfaces, which it forces apart. Volkmann declares this to be most improbable, and believes that the body gets jammed somewhere between the sides of the joint-end and the synovial membrane;² but in opposition to this idea it must be noted that on account of the imperfect fitting of the femur to the tibia, the gliding motion of the latter bone over the condyles is exactly the sort of movement that would be most likely to entangle a loose body. Moreover, if the body lay during such an attack between the synovial membrane and the outer surface of the bone, surely it would in some one of the many reported cases have been found; but I find no record of such a discovery during an attack. It is quite true that the loose body is sometimes so large that we can hardly conceive it to be capable of getting between the bones. But then there is no doubt that equally painful symptoms would be caused by its slipping into the intercondyloid notch, and becoming entangled between a crucial ligament and the bone, or between the two ligaments. When the surgeon sees a patient just after one of these attacks, he had better, if the joint be pretty full of fluid (for synovitis frequently sets in), postpone any search for the loose body until the sac is nearly empty. Even under favorable circumstances the body may not be at once detected; it may lie in some cranny, and there be quite concealed until dislodged. Generally, it is well to explain the condition of things to the patient, and beg him to spend occasional leisure minutes in a "mouse-hunt" for himself; but if the surgeon search for it, this must be done with the lightest possible touch, and with a hand acutely alive to any change of form or abnormal projection. When such a projection is found, it must not be directly pressed upon, but is to be surrounded at a little distance by several fingers of both hands, which are then made gradually to approach each other until all channels of escape are cut off; then a finger of each hand can be used to feel the body, to impel it hither and thither, examine its size, consistency, etc. The most common places for finding these bodies are the lateral surface of the outer condyle, and next that of the inner condyle; but I have also found them in front of the femur, just above the patella, and once or twice on the tibia just inside the ligamentum patellæ.

When by care the existence of a movable body in connection with a joint has been made out, the surgeon must ascertain whether it is really inside the articulation; in many cases, and especially when the substance enjoys a wide range of motion, this is very easy. But some that are really in the joint move but a very little way, and there are about the knees of some persons certain irregularities of the fascia, or lipomatous nodules, which have a degree of mobility, and might easily be mistaken for intra-articular bodies; for instance, that fold of the fascia which covers the vastus externus, a little way above the outer edge of the patella, has frequently, to my knowledge, been taken for a movable body in the joint. No lump should be considered as moving within the joint if its range of motion be so restricted that it is always found in one place, with its long axis always in the same direction,

¹ This sort of attack is sometimes due to the subluxation of a meniscus, or to some other internal derangement of the knee.

² Loc. cit., S. 580.

nor unless it can be induced to hide itself under some recognizable anatomical part; as, for instance, under the patella, the tendon of the rectus, a lateral ligament, or the ligamentum patellæ.

I do not think it possible to make out whether a body in the joint be cartilaginous or bony, or a mixture of both cartilage and bone; the softness of a lipomatous body¹ will generally enable the surgeon to distinguish it from other varieties.

The shape of the body can generally be roughly made out; but being felt through a considerable layer of soft parts, it commonly appears larger than it really is.

TREATMENT.—We may divide the treatment into palliative and curative; to the former belong all the methods that have been devised for retaining the false body in some harmless part of the joint-sac. Among these are various forms of bandage or plaster. The simplest, and by no means the least efficacious arrangement, is to cut a hole, of a size a little larger than the loose body, in a piece of adhesive plaster, and having maneuvered the body into some such advantageous position as on the lateral surface of either condyle, to apply the plaster in such a way that the body lies well within the hole. The same sort of arrangement may be carried out with an elastic or other bandage, or with a knee-cap, having an opening at the side corresponding to a part of the joint into which the body can be easily propelled. In certain cases, the use of a knee-cap stiffened behind by a steel splint, is the best treatment, and this more especially applies to joints which contain a large number of false bodies, for, as we have seen, such a condition is but a symptom or a consequence of disease, not merely of the synovial membrane, but of the whole joint-apparatus. Such a state could not be benefited by removal of the growths, which would only rapidly recur, but might, in all probability, be aggravated by the operation. But if dealing with one or two loose bodies, the surgeon will avoid disappointing his patient by at once informing him that any form of bandage can give but temporary and unreliable security, since sooner or later the body will escape from its control.

Another device is to fix the body in some desirable locality by means of a serre-fine, or by passing through it and through a fold of skin a hare-lip pin or wire suture, leaving this *in situ* until the resultant inflammation has glued the substance to the synovial membrane, or necessitates removing the instrument. This method cannot be very highly commended; it is by no means free from danger, since it is impossible to be sure that the inflammation produced by such a wound will reach the point intended and go no farther. Moreover, even if all go well—if the body adhere and inflammation subside—the movements of the joint are apt very soon to loosen or break down the new adhesions, when all the troubles recur. This accident we may endeavor to prevent, or at least to postpone, by using one of the bandages above described; but even with all possible precautions, recurrence of trouble is so common that it is well to warn the patient of its possibility.

The only real cure for the disease is by removal of the loose body. The operation may be performed in one of two ways—the direct and the indirect—the latter being sometimes called the subcutaneous method. The direct method was the earlier in priority, but was then almost superseded by the indirect, which again has given place to its older rival. The reason of this oscillation is as follows: Some twenty-five or thirty years ago, surgery, plentifully skilful and brilliant, was at the same time somewhat slovenly, not

¹ I have compared the sensation imparted to the hand by one of these bodies to the feel of an oyster squeezed between the finger and thumb till it slips away.

to say uncleanly; wounds of cavities, serous and synovial, were almost sure to suppurate. Now, whatever may be thought of the germ theory, of the spray, and of all the other minutiae of Listerian antisepticism,¹ there is no doubt that cleansing the hands, the instruments, and the patient's skin, by means of a powerful disinfectant, is a considerable safeguard against supuration. Thus, up to about thirty years ago, the direct extraction of loose bodies from joints was a very dangerous proceeding, and when the subcutaneous method of Delpech and Stromeyer became known, it was extended from the mere division of tendons to other operations, and among them to the excision of loose bodies from joints. The operation was largely practised, but very often failed, until Square, of Plymouth, introduced a somewhat modified method, dealing very freely with the synovial membrane and the periarticular tissues. It is his method which will be described.

The instrument must be broader than the usual tenotome, longer also in the cutting part, and, in order to fill or plug the rather big cutaneous opening, thicker and stronger in the non-cutting part. When this instrument has been introduced under the skin, it is moved to and fro, partly dividing, partly breaking down the periarticular tissues, until a cavity has been prepared, sufficient for the body to lie in when extruded; then the synovial membrane is pretty freely opened, so that there shall be no impediment to squeezing the body out of the joint and into this new-formed cavity. Here it is left for some days, until the synovial wound has had ample time to heal, when it may be cut down upon and removed.

The direct method is performed by manipulating and keeping the body in some part of the joint readily accessible from without, and then shifting the skin over it as far as it will go; the surgeon, with a very sharp knife, cuts straight into the joint, not on the cartilage, lest the pressure of his scalpel should cause it to slip away; but a little on that side to which he has learned that it most readily passes. The opening in the synovial membrane should be quite free enough to let the body pass easily, and a little pressure towards the opening should cause it either to jump quickly or move slowly, to glide out of the wound; in either case, the track should be closed by the pressure of an assistant's hands immediately behind the body. Sometimes, in spite of all proper arrangements and skill, the cartilage will not come to the synovial opening, and it may be necessary to pass in a fine pair of tenaculum forceps to seize it and bring it forth. Occasionally it will be found to be still attached to a pedicle, which may either be twisted until it gives way, or simply cut. If the spray and carbolic acid have been used, the site of operation should be drained. The surgeon may, if he choose, pass a probe through the operation wound into the joint, and on to some dependent part of the sac, cut down upon the probe's point, and thus draw in a drainage-tube; or he may simply pass a drainage-tube into the operation wound, and, if he have been able to choose a dependent part, this will be the safest plan;² nor should the tube do more than just intrude into the synovial wound. If the simpler and less irritating dressing with boro-glyceride have been employed, no drainage-tube, or merely a tube just passed into the lips of the outer wound, is necessary.

The after-treatment consists chiefly in affording complete rest to the joint, one of the many splints already so often referred to being applied. The wound should be dressed in from twenty-four to forty-eight hours, according to the

¹ I place the words thus, because there are other antiseptics and other modes of insuring their action than those introduced by Lister.

² I lately saw a case, under the care of an excellent surgeon, in which all the Listerian precautions had been employed, including the use of a drainage-tube through the joint. I attributed the violent suppuration that ensued to the irritation of the synovial membrane by this foreign body.

amount of secretion, and the splint should be arranged in such wise that the dressing may be done without disturbing the limb.

In comparing the results of these methods, we find that the direct method is somewhat more dangerous to life and limb than the indirect, and that the latter, though by no means free from danger, is especially liable to failure, by impossibility of extruding the body through the incisions made. These two sorts of mishap were at one time, according to Larrey's tables, so frequent, that more than half of the cases operated on either failed or were fatal.

Here subjoined are two tables, that of Larrey, coming down to 1860, and one of my own, embracing cases recorded since that date.¹

H. LARREY (1860).

	Direct.		Indirect.	
	Number.	Per cent.	Number.	Per cent.
Success	98	74.8	19	48.7
Death	28	21.3	5	12.8
Failure	5	3.8	15	38.4

BARWELL.

	Direct.		Indirect.	
	Number.	Per cent.	Number.	Per cent.
Success	44	91.6	29	72.5
Death	4	8.4	1	2.5
Failure	—	—	10	25.0

JOINT DISEASES WHICH ARE DUE TO OSTEITIS.

I. ACUTE ARTICULAR OSTEITIS.

We have hitherto had to do with a class of diseases which commence in the synovial tissue and its immediate neighborhood. Those which primarily affect the bones, and which after a time spread by one of various ways to the joints, must now engage our attention. They are not less interesting than diseases of synovial origin; in certain points of view their study is more important, since in many cases their early recognition—before the joint itself has become deeply involved—may enable us to prevent a long process of disease which often has a most undesirable termination. The maladies in question attack the bone in the immediate vicinity of a joint—the articular extremity in adults, the epiphysis or shaft-end in younger people; in both, a short bone, as of the carpus or tarsus, may be the seat of disease.

A very severe disease of bone, namely, acute osteo-myelitis, or acute osteitis, must first be studied. By some authorities the disease is ascribed to systemic causes, and is likened to erysipelas or phlebitis (osteo-phlebitis). By others it is ascribed to local chilling or traumatism. But the attack often occurs when no or very trifling exposure or injury can be traced; it is severe, out of all proportion to the injury received; and it is not unfrequently multiple; we cannot therefore, I conceive, logically ascribe a disease which is so violent to a very slight external cause, although some chill or hurt may determine the time and place of its commencement.

Acute osteo-myelitis is especially a disease of young life, during which period the bones, undergoing rapid growth and considerable change, are extremely vascular. The preference of the malady, too, is markedly for

¹ The tables may be taken somewhat as guides to indicate the results of the two methods, but it need hardly be pointed out that the earlier statistics do not apply to the present time, and that in collections of published cases the numbers of failures and deaths are very much below the reality.

those parts in which there is the greatest amount of growth, and therefore most vascularity, viz., in the following order:—

1. Lower end of femur.
2. Upper end of tibia.
3. Upper end of ulna, lower ends of humerus and of tibia.
4. Upper end of femur.
5. Upper end of humerus.

The local manifestation begins with hyperæmia of the parts within the bone, namely, if the site of disease be at a joint-end, hyperæmia of the subdivided medulla and of the cancelli; then inflammatory products, solid and fluid, are rapidly poured out, and extravasation in larger blotches or smaller specks takes place. A little away from the chief focus of disease, where the action is a little less turbulent, granulations are thrown across the medullary cavity, thus cutting off the inflammation and its morbid products from the neighboring healthy parts. If the disease remain within the same limits, these granulations become further developed into a coarse, fibrous or fibro-cartilaginous structure, which in some cases is ultimately ossified. If the disease spread further along the central cavity, the granulations rapidly dissolve away. Whatever their fate may be, the course of the disease at its point of chief action is not thereby affected. The medulla, under the influence of inflammation, loses its consistency, and rapidly breaks down into liquid oil, with which the inflammatory fluids and the extravasated blood intermingle. All this new material, being inclosed in a bony case with unyielding walls, produces very considerable tension or pressure inside the cavity.

But the action is not confined to the contents of the medullary canal. It either simultaneously falls on, or very soon spreads to, the bone itself and the periosteum.¹ Hence, in all cases we find both these structures greatly changed; the bone is softened and red, and bleeds if cut; the Haversian canals are enlarged, and contain, besides the dilated vessels, inflammatory exudations, here and there extravasations, and oil; while the periosteum is very hyperæmic, softened, and separated from the subjacent bone by an effusion of blood-stained serum, by extravasations, and (save in diffuse cases), at the confines of the disease, by granulations. Even at this early stage all these may be mixed with blotches and drops of oil—dissolved medulla—which have been forced out of the cavity by the intraosseous pressure above alluded to.

In the mean time, the parts surrounding the affected structures also participate in the inflammation, sometimes sooner, sometimes later, according to the more or less phlebitic nature of the case. The deep veins leading from the inner or from the outer parts of the bone are engorged, and either by becoming themselves inflamed, or from absorption of pus, or from both causes, permit the formation of thromboses, which often extend to a considerable distance from the focus of disease, and involve veins having no direct connection with the bones. Hence, extravasations and blood-stained serous exudations occur in the track of vessels, chiefly in the intermuscular spaces; and in these, beginning with the deeper ones, the tissues tend to suppurate, and, if the disease persist, do actually suppurate.

Thus this stage presents, supposing a transverse section to be made through a limb thus diseased, the following appearances from the centre outward: The interior of a bone (cancellous structure), which is deeply red from hyperæmia and blotched with extravasations, and from the cavities of which flows

¹ In describing these pathological changes I am accustomed to teach that the outer and inner membranes of a bone are in direct continuity one with another by means of the Haversian lining-membranes and canalicular fibrillæ; that there is complete reciprocity of action between those two structures, retarded only a little by the greater or lesser thickness of the bone, that is, by their greater distance one from the other.

medullary oil, also somewhat tinged. The substance of the bone itself is red and softened; around it lies blood-stained serum intermingled with oil, with here and there a fugacious granulation. Outside this, and containing it, is the congested and softened periosteum, surrounded by muscles separated from each other by intermuscular spaces, in which turgid veins ramify amid reddened serum and discolored extravasations.

Up to this point it is possible, though unfortunately rare, that retrogression may occur; the vascular turgescence may subside; the serum may rapidly, the extravasations more slowly, be absorbed; the intraosseous pressure may diminish, and then cease; the periosteum may again come in contact and form connection with the bone; all the morbid conditions may clear up, and this without any necrosis or suppuration. But such an event is very rare; and, if it is to take place at all, retrogression must commence not later than the first week, for the next stage follows quickly—occasionally so quickly that this earlier stage, though doubtless no inflammation can produce pus at its very commencement, appears to be clinically indistinguishable from it.

The next stage is the suppurative. It consists in the change of the mere exudative stage into that of pus formation. The districts which have been described above as occupied by extravasations and oil-globules mixed with serum, now contain the same elements, mingled with more or less discolored and generally offensive pus. But now come the points of chief importance in this change: The bone throughout a smaller or larger district dies, and the veins, already filled with soft, partially broken-down blood-clot, are exceedingly prone to absorb the unhealthy fluids, and produce rapid pyæmia.

Whenever the diseased action takes place near the epiphyseal line—and, indeed, this is the more usual situation—the junction is involved in the action, and the epiphyseal end of the bone is cast off; a circumstance which led Klose¹ to name the malady “*Epiphysentrennung*” (separation of epiphyses); and this part, in the severe cases we are depicting, usually dies, and lies as a sequestrum among the discharges.

MORBID ANATOMY.—Such very acute osteitis is not common in England, but in certain parts of Europe it appears to occur in the form of an epidemic, and it was from this sort of case that Chassaignac and Klose drew their highly colored pictures. Its morbid anatomy may be summed up thus: In the bone cavity are found large districts of purple, intense hyperæmia, with blotches of extravasation, and dark-colored and offensive pus, mixed with disintegrated medulla. Outside the bone are very much the same materials; the bone itself, dying or dead, is of a greenish or black hue. All this is contained in a highly inflamed and distended periosteum, outside of which the soft tissues are soaked in a blood-stained serum or pus. The veins are turgid with semi-coagulated blood, discolored, and evil-smelling. The separated epiphyses lie bathed in pus at the ends of the bones. But generally the course of the disease, though more than sufficiently violent, is less acute than above described. The same, or probably less intense local changes are brought about more gradually, with a distinct incubation period—an interval of inflammation previous to pus formation—and then a slower suppuration, and a diastasis, whose more gradual steps may to a certain extent be followed, for sometimes this occurs in an incomplete form. Ulceration taking place all around the junction forms a deep groove, but not a complete separation, the epiphysis becoming twisted on the shaft. In certain other cases, again, the epiphysis by further ulceration becomes entirely separated, but, owing to the slower method of the process, does

¹ *Prager Vierteljahrsschrift*, 1858.

not die. On the contrary, it not only continues to live, but may again become attached to the shaft, though in an abnormal, and perhaps very deforming position. Such was the case with the patient from whom the preparation here depicted was taken.

Fig. 603.



Acute osteitis ; separation of epiphyses.

With great difficulty I steered her through all the dangers of acute osteo-myelitis; but she could and would bear no appliance to the limb. The epiphyses were completely separated, and when she had sufficiently recovered I advised amputation. This was refused for a long time; when accepted, the epiphyses were reunited, but in very bad position. The shaft of the femur was extensively diseased, and suppuration was wearing out the patient's small amount of strength.

This disease has certain relationships with erysipelatous phlebitis, and particularly must it be pointed out that the malady is sometimes multiple; indeed, an instance is mentioned¹ in which every important epiphysis of the body was separated. In this, as in certain other cases of multiple disease, the primary attack preceded, by a considerable interval, the others, which appear to have been pyæmic. In some other cases the different attacks have been almost simultaneous (phlebitic). The general or systemic condition has been, till now, left unmentioned, that the local pathology might be more succinctly given; but before passing on to consider the articular phenomena, it must be noted

that the sharp pains and the rigors which usher in the attack, are succeeded by strongly marked pyrexia, the temperature reaching 104° or 105° F. or occasionally even more. Very soon the fever assumes a typhoid character, increasing and deepening if the disease is to end fatally.

It is singular that the joint-affections contemporaneous with and in close proximity to such tumultuous disease, should often be of a very mild nature. Herein we must make a distinction—quite overlooked by Chassaignac², by Klose, and by Paul—that in many cases, especially in those which have been caused by injury or by some definite exposure, an articular affection may precede, or at least be cotemporary with the bone disease, and yet be in no way dependent upon it. Such simultaneous disease may even improve and almost disappear, while the osteitis is in progress and approaching its culmination. Moreover, these same writers insist too strongly on the constant severity of the secondary, the dependent joint-disease, which may be, it is true, a severe suppurative synovitis, with or without pyæmic affection of distant joints, but is more commonly a simple sero-synovitis, due to extension of in-

¹ Demme, Wiener Medizinal-Halle, 1864.

² Gazette Médicale, 1854, Nos. 33, 35, 36, 37.

flammation from the periosteum. Another not unusual complication is a form of hydrarthrus with considerable fringe-hypertrophy which is rapidly produced.

The suppurative synovitis is caused by the products of inflammation passing into the joint cavity; but this has not the same violence as when pus is suddenly poured into a healthy joint, for the disease has progressed, however rapidly, still by degrees along the periosteum, as also through the bone and cartilage. Thus the synovial membrane is already in a morbid condition, and the cartilage rarely gives way, largely and suddenly, so as to admit a flood of inflammatory fluids into the joint, but is rather perforated in small holes, giving passage to slow transudation.

Diastasis does not itself produce any diseased action in the joint, save that of position, unless the line of the epiphyseal junction lie within the synovial area, in which case there occurs a more or less sudden influx of pus into the cavity, and the most acute suppuration of the joint may follow. When, however, very acute osteitis attacks, not the end of the shaft, but the epiphysis, the joint-affection more immediately accompanies the disease. Acute epiphysitis is a rarer, and, as a rule, a more destructive malady.

From the above account it is evident that we have to do with a more and with a less severe affection; the former is, as far as our present knowledge goes, closely related to phlebitis, and is combined with or immediately followed by septicæmia and pyæmia. The latter, though also an osteo-myelitis, is circumscribed, does not produce inflammation or thrombosis of veins outside the bone, and is often overlooked, its symptoms being very obscure, and frequently ascribed to rheumatism. If its course be favorable, the periosteum will again adhere, and even the bone, though sclerosed, and perhaps for months the seat of obscure and intermittent pains, may eventually quite recover. Or a certain portion may die, around which new periosteal bone will form, when the case takes on the usual well-known form of osteitis and thickening around a central sequestrum, which, after a year or more, will produce abscess in the soft parts, and may be removed by operation.¹ Again, in certain cases no portion of the bone will necrose; but there will remain an intrasosseous abscess, which may at once give rise to severe trouble, or may become surrounded by sclerosed bone and slowly desiccate. Occasionally, too, in the cancellous structure, the pus, scattered in a chaplet of abscesses, will also dry up. When, as often happens, fresh disease sets up new symptoms, these caseated deposits may be revealed, and are very likely to be mistaken for tubercle.

SYMPTOMS.—This disease usually attacks persons under seventeen years of age; sometime babies of a year old. Nine months is the youngest age at which I have seen it. In some instances an epidemic influence appears to have generated very many cases of acute osteo-myelitis in a certain area; and this, when recognized, greatly facilitates the diagnosis. Occasionally, in either epidemic or sporadic cases, some definite injury or exposure precedes by some days the attack. The first symptom may be a severe rigor, followed by pyrexia; such cases are more likely to result in the phlebitic variety of the disease, than when the primary sign is severe pain and aching of the limb. The pain, be it lancinating, burning, aching, or bursting in quality, is always accompanied by a powerlessness which is very characteristic, which the patient

¹ While writing these pages, I have removed from the lower part of the femur a sequestrum, which was surrounded by new periosteal bone, and which was more than one-half the circumference of the shaft, embracing its entire thickness, and two inches long. The patient, a child aged 10, had received a blow two years previously, and after a fortnight had suffered severe pains and fever, which lasted a month; after this, though she slowly got better, she never recovered perfect or painless use of the limb.

feels as a sensation of great weight—as though the limb were of lead—and which the surgeon sees in every motion of the sufferer. If from any cause its position must be changed, the patient either drags the limb hanging passively from the trunk, or lifts it with his hands.

In the worst cases, those of the osteo-phlebitic variety, the general symptoms are, severe and remittent rigors (these are, in some cases, not strongly marked), with considerable pyrexia, the evening temperature reaching to 105° F. or more; the tongue furred, and brown in the middle; appetite entirely absent; insomnia almost persistent; constipation at first, perhaps followed after a time by diarrhœa and vomiting. Icteroid coloration of the skin is generally present.

In the less urgent cases, these symptoms are greatly modified; the pyrexia is much less marked, and the disturbance of the digestive functions less apparent; yet there is sufficient evidence of illness to cause us to recognize the presence of some inflammatory disease, to the locality of which the pain clearly points.

Yet for about five days, more or less, from the commencement of the malady, no local change can be perceived; afterwards a deep, local swelling may be detected, which is œdematous at the surface, and doughy or boggy beneath, while still deeper pressure reveals a perfectly hard substratum. This enlargement ceases by a sudden edge, beyond which the limb is, to the touch, normal or nearly normal. The tumefied part is exceedingly tender upon deep pressure; but beyond the boundary of swelling the tenderness ceases quite abruptly. This sharp limitation of swelling and tenderness is a very important characteristic of the disease.¹

Again, there is an interval of from five to nine days, during which little alteration takes place except increase of swelling, and then begins a change in the color of the skin.² In my experience this is bright-red or reddish-purple, and shiny, the color disappearing momentarily on pressure with the finger; but in certain cases, especially of the epidemic, phlebitic form, it is, according to Demme, of a dirty clay color as long as acute œdema is present. Large, distended veins ramify beneath the integument, but in the cases marked by red coloration they are much less perceptible (though present) than in the others.

Abscess, except in the most acute cases, can rarely be detected from the surface till after a fortnight.

These symptoms, in their entirety, form a picture so different from ordinary phlegmonous erysipelas, that mistake is hardly possible; and to make an incision for merely diagnostic purposes (Chassaignac) is not, in my opinion, justifiable. Oil drops (from the disintegrated medulla), which under such circumstances would be found in the pus, might also be due to certain other forms of disease. Incisions can only be justified as a resource of treatment.

When the surgeon perceives, during the course of the above symptoms, the sudden appearance of a marked and peculiar deformity about the joint, he may suspect diastasis, and must carefully watch the case for the next few days, during which the distortion gradually, though pretty rapidly, increases. The diagnosis between separation of an epiphysis and pathological dislocation is in part rational, in part physical; thus, the former can only occur during early life, and is a much more common sequela than the latter of acute osteomyelitis. The abnormal mobility is greater and of a different sort from that of

¹ See also Chassaignac, loc. cit.

² Demme states that this coloration does not take place until the periosteal abscess approaches the surface. I am, however, in a position to affirm that this is by no means always so; I have seen intense redness or purplish redness of the skin, in two or three cases, while the abscess has been still very deep.

luxation; it takes place above or below the joint, the relative position of whose component parts, condyles, etc., remains unchanged.¹ After a few days the truncated end of the shaft, very different in shape from the joint-end, makes a projection beneath the skin. Occasionally the edges, both of diaphysis and epiphysis, can be felt. It must here be noted that not unfrequently muscular apophyses also become separated.

The period at which diastasis occurs varies very much, according to the violence of the disease. In bad cases, those that usually either prove fatal or require amputation, the separation occurs about the tenth day. When this event is deferred beyond the month, there is much hope of recovery, but, of course, with much deformity and crippling. Even when all acute fever has subsided, chronic suppuration and extensive bone disease may call for amputation. The primary joint-disease, that which arises prior to or simultaneously with the osteo-myelitis, and which is due to the same cause, may be very slight or more severe; in the latter event, it may very considerably embarrass diagnosis. In young children—those under six years—a tolerably severe traumatism may set up a smart sero-synovitis; in older persons, an exposure to cold may first induce a rheumatic synovitis, together with vague rheumatoid pains in other joints. Thus, in the one malady an attack of severe local pain is very apt to lead to the conclusion that a simple synovitis is assuming the suppurative character; in the other condition, the symptoms greatly resemble those of acute rheumatism expending its chief force on a single joint.² As regards the differential diagnosis, it must be observed that in osteo-myelitis the limb lies straight, and that the abnormal flexion of suppurative synovitis does not occur; the appearance of passive helplessness is characteristic; the locality of chief pain and tenderness is different, and, unless the joint itself be much inflamed, the points of synovitic tenderness are absent. The pyrexia of osteo-myelitis is of quite a different type from that of rheumatic fever; the quality of the urine is not that of uric-acid disease; the sweating is not profuse, but, on the contrary, the skin is generally dry. When sweating does come on, it has not the great acidity of rheumatic perspiration. In locality and quality, the pain is quite different from that of rheumatism, unless neuralgic rheumatism, and this the temperature excludes.

The joint-affections consecutive to and dependent on acute osteo-myelitis are often, as already stated, comparatively mild, and may, indeed, in the violence of other symptoms, escape notice. A serous or purulent synovitis, much masked by surrounding tumefaction, hardly forces itself into notice; but, if it should become suppurative, the flexed position of the limb, combined with tension below the place of original disease, and a probable sudden increase of pyrexia, combined with or preceded by rigors, should at least awaken suspicion.

Pyæmic complications, involving either the internal viscera or other joints, manifest themselves by symptoms which have already been discussed both in this article and in other parts of the Encyclopædia.

TREATMENT.—Chassaignac, who first drew attention to acute osteo-myelitis,³ followed by G. Roux, Klose, and Gosselin, advocated immediate, free incisions down to the bone. This treatment was eminently unsuccessful, being in the vast majority of instances followed by pyæmia and death. A few years afterwards Dr. Demme refuted these views, and insisted on the necessity of avoiding any opening of the skin, as long as the more acute phase of pyrexia continued.

¹ In case there is much swelling, these positions cannot well be made out.

² Demme entitled his paper, in *Langenbeck's Archiv*, *Die pseudorheumatische Progressse*.

³ *Mémoire sur l'ostéo-myélite*. Paris, 1854. *Gazette Médicale*, 1854.

My own experience of this malady, which has not been small, inclines me so far to the views of Demme, as to think that incisions should not be made merely for routine's sake, but that there are, nevertheless, certain cases in which either extreme tension or early suppuration renders incisions absolutely necessary, and that then, if judiciously employed, they are salutary.

The treatment, therefore, should be carried out on the following lines: After administration, if needful, of a purge, the patient is to be placed on a nutritious and supporting diet, stimulants being in all probability necessary. Opiates by the mouth or subcutaneously must be given. The limb is to be placed at entire rest on a splint, and especially should be slung; and of all local applications, compresses, put on hot and covered with thin mackintosh, are, in my opinion, the most efficacious; they cause transpiration, appear to relieve the distended vessels, and tend to keep the blood within the veins liquid and in motion.¹ If it be wished to add the acetate of lead or tincture of opium to the fluid of the compress, there can be no objection. From day to day the part must be examined, attention being paid to any centrifugal spread of the inflammation, and more especially to any increase of swelling, or to fluctuation indicative of suppuration.

When the deep, hard swelling softens, or the change of color, already described, takes place—which occurs in from five to fourteen days—an opening will, in all probability, be desirable. Occasionally these symptoms are not so strongly marked but that the surgeon may have some hesitation, in which case an exploratory trocar may be first introduced. In other cases, combined with the above symptoms, a spot may be found at which fluctuation is perfectly distinct; here an opening may be made long enough to admit further exploration with the finger. The great object in treatment at this stage, I have no hesitation in affirming, is evacuation of pus from the vicinity of the bone, as soon as detected. Hence, the opening must go through the periosteum, and, if it have to extend through much thickness of tissue, effusion of any great quantity of blood can be avoided by making the deeper parts of the cut not very long, introducing into the periosteal wound a pair of dressing forceps, and, by rapidly opening the blades, tearing up the rest.

The surgeon, however, must procure a sample of the pus, as free as possible from blood, and examine if any considerable quantity of oil float on its surface; and if that be the case, he should perforate the bone. He need have no fear of missing the spot where intraosseous pressure is well marked, since it is quite sure to be opposite the place of subperiosteal abscess; nor need he lie under apprehension of doing harm. No complication of instruments is necessary; a simple, well-tempered, and sharp, carpenter's gimlet is all that is required. Throughout the operation, care should be taken not to injure or unnecessarily tear the periosteum. When all is complete, the wound should be well washed out with an antiseptic; a solution of chloride of zinc, forty grains to the ounce of water, is, I think, the best, but carbolic acid may also be used. Unless very extensive, no part of the wound should be sutured, but it may be loosely filled with lint or absorbent cotton steeped in an antiseptic fluid. A drainage-tube should be passed into the furthest depths of the wound, and retained for at least a few days. Many cases under this management completely recover.

If, in spite of all efforts, the disease continue to spread, a repetition of the operation, as far as may be wise or as the patient's strength may permit, must be carried out. But if the spread be rapid and the appearances indi-

¹ Demme recommends the application of a very strong tincture of iodine, 60 or 70 grains of pure iodine to the ounce of absolute alcohol, and this to be repeated to the verge of vesication. I have not traced any special advantage to this treatment; it adds to the pain, and the horny condition left may give rise to subsequent trouble.

cate wide destruction, the repair of which will of necessity destroy the patient, amputation is the sole resource. If, however, symptoms of pyæmia, which must be carefully looked for, appear, the treatment must be carried out on the lines already indicated (see page 408).

During the whole course of the disease, the surgeon must endeavor to prevent diastasis by enforcement of rest in a good position; and especially if the parts about the knee be affected, a straight posture must be maintained, as otherwise the mere power of the flexors will, without blow or sudden movement, produce that displacement. But, except in the more rapid or osteophlebitic form, separation of the epiphysis is not a sudden event, and, therefore, while the groove of separation (see page 461) is being gradually formed, the greatest care will be necessary to prevent any movement which might fracture the remaining connection; for while any portion of attachment remains, separation may be avoided and repair hoped for. When diastasis has taken place, we need not absolutely despair of reunion, provided that the neighboring bone be fairly sound; the problem, and it is often a difficult one, is to insure that union shall take place in the best possible posture, for at all joints there is great tendency to deformation towards the side of flexion. No appliance seems so well calculated to insure this result as the plaster-of-Paris bandage, applied while, by extension or otherwise, the limb is held in position. If mouths of sinuses, or the remains of abscesses, be anywhere found, corresponding openings must be made in the bandage.

The management of the accompanying joint-disease must depend on its form and severity. If the surgeon have to do with a mild joint-affection tending to become chronic—and, if so, remarkably obstinate—he will employ such treatment as has been described in previous pages. The more severe affections, too, must be treated on principles already laid down. Especially would I here point out, that, if the synovial tissues suppurate, free incision and thorough drainage are particularly necessary, and that the opening thus made must be utilized for making a careful investigation into the state of the bone.

In case one or both epiphyses be found lying in an abscess, loose and necrosed, there will be no possibility of restoring the joint, nor, as long as the sequestra remain, of procuring ankylosis; moreover, the presence of the dead material keeps up suppuration, which may go on to the exhaustion of the patient. It is therefore evident that these must be removed; but there is some choice as to the method, which must be guided partly by the condition of the patient's health, partly by the anatomical position of the joint involved. Thus, if the patient have suffered much, or if suppuration have been considerable, so that the bodily powers are unequal to a rather long and arduous work of repair, it may be desirable, whatever be the joint involved (except the hip), to amputate; otherwise, the surgeon may for most articulations cut into the abscess widely enough to remove the loose ends, drain the cavity thoroughly, and, keeping the part at rest, endeavor to obtain such union, fibrous or otherwise, between the ends of the shafts, as shall enable the limb to serve some useful purpose. This, especially, may be the result with the joints of the upper extremity, and more particularly with the elbow.

If the disease be at the knee, its most frequent seat, sundry considerations become involved. It is very doubtful indeed, if, the necrosed epiphysis or epiphyses being removed from an abscess-cavity, it would be possible to secure synostosis of the femur and tibia; and if this should not occur, the limb would be very useless.¹ Moreover, if synostosis should take place, the limb would hardly grow from the end which had shed its epiphysis, and if the patient

¹ The condition of things is very different from that in which an excision of the knee-joint is usually performed.

were in early life, a very short limb would result. In all probability, therefore, when an acute osteo-myelitis has caused separation and death of one or both epiphyses about the knee, amputation will be the best treatment, that which is most likely to save life, and that which will leave the most useful form of member behind; a good stump being better than a short, feeble, and deformed limb.

II. CHRONIC ARTICULAR OSTEITIS.

Osteitis is much more frequently subacute and chronic than acute, so that, both in private and in public practice, we constantly meet with the first-named varieties in different forms affecting adults and children. Chronic bone-inflammation may be due to various constitutional dyscrasæ—*e. g.*, syphilis, scrofula, or rheumatism—or may be merely traumatic and local. It is not desirable that I should here discuss the histology of osteitis further than may be necessary for the elucidation of our present subject.¹ It must, however, be said that: (1) Osseous tissue, even that apparently solid case which surrounds the medullary canal of a long bone, is traversed and pervaded by channels containing vessels and membranes, and the small non-vascular districts between those canals are studded with stellate cells, which, together with their branches, subdivide the tissue into microscopic spaces; (2) the nutrition of the bone is effected by fluids conveyed along these channels, first, by the vessels into the Haversian canals, and secondly, from thence by the minuter passages, into the lacunar spaces; and (3) by means of these minute membranous ramifications, the periosteum and endosteum are placed in close interrelation.² These are all concerned in the nutritive mechanism of the bone.

In parts where, for the sake of combining increased size with lightness, the bone elements, instead of being concentrated into an apparently solid mass, are scattered in thin plates inclosing interspaces (cancelli), vessels, and therefore Haversian canals, need not be channelled through the tissue itself, but the cavities contain the arteries, and are lined by subdivided prolongations of the vascular endosteum; nevertheless, lacunar spaces and cells are still necessary. In fact, bone is connective tissue the ground-substance of which has been hardened by the deposit of lime-salts, and in which the connective-tissue cells still persist, sometimes forming an integral part of the membranous constituents, sometimes scattered or arranged in the harder portions. As the health and life, or the disease and death, of ordinary yellow connective tissue depend on the action of these parts, so do the healthy and diseased nutrition of the ground-substance of bone depend upon the functional integrity or disturbance of the cellular elements, and of other cellular elements (migratory leucocytes) which may be added to them.

An inflammation of areolar tissue may have either formative or destructive qualities. It may tend to tissue formation, whereby the inflamed spot becomes both harder and larger, or, in other words, is swollen and indurated. Bone, being rigid, does not often swell by the interstitial deposit of new tissue-ele-

¹ My investigations and views on the process of inflammation in bones, and the points of difference in my views from those of Billroth, are set forth in my work on Diseases of the Joints.

² This view of the structure of bone might also be explained by pointing out the similarity, nay almost the identity of appearance of the ramified connective-tissue corpuscles of connective-tissue, and the ramified lacunar spaces of bone; if, for instance, we refer to two illustrations in Quain's Anatomy, we see there excellent representations of the former bodies; they also admirably portray the microscopic appearance of a thin portion, say a cancellar lamella, of bone; in solid bone as of a shaft, the elements are the same, only more regularly arranged.

ments, but it frequently becomes extremely dense and heavy—osteosclerosis.¹ Areolar-tissue inflammation may, on the contrary, have destructive tendencies, viz., to suppuration and ulceration. So also bone-tissue, when inflamed, may undergo softening and rarefying processes (osteo-malacia, osteo-porosis), may ulcerate (caries), or may become gangrenous (necrosis) or phagedænic (caries necrotica). All these changes are induced by various acts of the cellular materials so richly implanted in that lime-bearing ground-substance which confers upon the structure its mechanical strength and rigidity.

The parts of bone, which for the present purpose are interesting to us, are the ends of long bones and certain short bones, as of the tarsus, which form integral parts of joints, which remain for many years of life in great part cartilaginous, and which afterwards become spongy or cancellous. The spongy texture is inclosed in a very thin case of bone, freely perforated by vessels, except on the surface which looks towards the joint.

Primary inflammation of the epiphyseal end of a long bone is uncommon in adult life, and, when it does occur, attacks by preference a small bone, such as a phalanx. Short articular bones, as of the carpus or tarsus, may be inflamed at any period of life, but also most commonly in youth—from eighteen to twenty-four; chronic idiopathic inflammation of the ends of the femur, tibia, or humerus is rare.² In young people, especially in children under ten years of age, the joint-ends of the large bones are very frequently the subject of strumous inflammation. The reasons of this proclivity at an early age are not far to seek: first, all strumous manifestations are most common in youth; and secondly, the great nutritive activity and ossifying processes at the epiphyses, accompanied by considerable hyperæmia, supply that slight irritation, to be responded to by prolonged inflammation, which supplies Billroth with his definition of strumous disease (see page 411).

The anatomical conditions are these: The bone-end or the short bone, as the case may be, is a mass of cartilage, in the midst of which is a growing osseous nucleus. On account of that growth the cartilage is very vascular, especially in the neighborhood of the nucleus. In most large joints the epiphyses are not fully ossified until about the age of puberty, and they retain their separation from, and their complete nutritive independence of, the shaft, for a much longer period.

When osteitis, or, as it is termed under these circumstances, epiphysitis, attacks a bone-end, whose nucleus, already cancellar,³ nearly fills the whole space, the usual termination, in strumous children, is osteo-malacia and suppuration, with perhaps some necrosis. The focus of suppuration, unless diffuse, is frequently surrounded, or at least subtended, by an area of sclerosed bone, just as in soft parts a localized abscess is shut in by indurated tissue.

If an almost mature but inflamed epiphysis be cut across with a fine saw, the inflamed point, or, when the action extends over the whole structure, all the cut surface, will show either spots of redness or a uniform, red coloration, and from the opened cancelli will ooze a more or less opaque and milky fluid, partly consisting of medullary oil, and partly of a cell-charged serum which may not as yet deserve the name of pus. At a somewhat later period,

¹ The enlargement of bone which is so frequently met with clinically, is, as a rule, due to deposit on the surface, but I think that the possibility of interstitial enlargement has been too dogmatically denied, as witness the condition, not very uncommon, called osteitis deformans. Moreover, I have had under observation for the last six months a child, aged 7, with very chronic osteitis of the tibia; the bone is not only larger than the other in circumference, but is also $1\frac{1}{4}$ inches longer.

² Arthritis deformans and the affections due to nerve-disease are excepted.

³ The nucleus in earliest life is solid.

the cancelli will be found stuffed with granulation-tissue, so tightly that it protrudes beyond and conceals the cut surface of the lamellæ. These latter become softer and thinner, and may in some place, larger or smaller, disappear, leaving in the worst and most advanced cases, instead of the normal, spongy bone-tissue, a mere soft mass of granulations, permeated by thin trabeculæ of softened bone, the remains of the lamellæ, deprived of lime-salts and rapidly disappearing.¹ In the new substance thus produced, and, as it were, substituting itself for the bony structure, many degenerations occur, as, for instance, spots of caseation, which, especially where vascularity is deficient, surround groups of giant-cells, a sort of change considered by some to be tuberculous. Fat, too, is often present in large quantities in the cells themselves, and lying diffused among them; pus also may be found, sometimes diffused, but more often gathered in little abscesses.

The fat above alluded to results from a degeneration occurring in granulations that have persisted for some time; this must not be confounded with a sort of osteitis peculiar to infantile life, in which the fattiness is primary, appearing to arise simultaneously with the inflammation. This fatty osteitis is at present little understood. Often in making a section of an inflamed epiphysis, the saw, the knife, and the hands, all become covered with oil. In attempting to obtain a lamella or section for the microscope, one finds all obscured by oil-globules, and frequent boiling in ether will hardly remove this redundancy of fat, with which not only the granulations but the bone-substance itself is soaked. In such conditions the cancellar plates are very thin, and are soft from deficiency of lime-salts, which I have no doubt have been dissolved slowly by oleic or margaric acid. Fatty osteitis appears to be somewhat antagonistic to suppuration, until a rather late stage; nevertheless, one occasionally finds an abscess in the midst of such disease, and subsequently the whole part involved may break into diffuse suppuration; but neither is found, as a rule, until the bone is quite softened, and, as a bone, almost destroyed. The subject is extremely obscure, but I think we may state as a fact that fatty osteitis, though occurring in strumous children, is never tuberculous, nor associated in any way with fatty degeneration, properly so called. It is singularly painless throughout its first stages; when suppuration occurs, it is rather widely spread throughout the bone-end.

If an osteitis, fatty or otherwise, of a short bone or of an epiphysis,² results in abscess, the pus, with the débris of inflamed tissues, or perhaps also with a sequestrum, will sooner or later tend to make its way towards a surface. If an abscess lies near to, travels towards, and opens into the joint, very evil, perhaps disastrous, consequences may follow. If it passes towards a lateral surface, the result will be much controlled by the relationship between the epiphyseal line and the capsule. In case the synovial membrane extends beyond that line, pus coming that way will, as in the former case, penetrate the joint; whereas, if the point towards which the abscess tends be outside the capsule, the joint may escape with little damage. So, also, when the abscess lies near and intrudes on the epiphyseal junction itself, much depends on the above point of its anatomy; but there is the additional possibility, if the pus

¹ The mode in which the membrane lining the cancelli granulates, how the lacunar bone-cells proliferate, how these products soften the bone-tissues, first dissolving out the lime-salts by means, as I believe, of a fatty or, as Billroth thinks, of lactic acid, and afterwards permeating and absorbing into their substance the remaining fibrillated matrix, cannot properly be considered in this article. The whole matter has been fully discussed by Virchow (*Cellular Pathologie*), by Billroth (*Chirurgische Pathologie und Therapie*), by Volkmann (*Sammlung klinischer Vorträge*, and *Langenbeck's Archiv*, Bd. iv.), by myself (*Diseases of the Joints*), and by others.

² I am here speaking only of epiphyses which are matured, that is, in which the bone has already entirely or very nearly occupied the cartilaginous matrix, and has become cancellar.

be large in quantity, that loosening or separation of the epiphysis may likewise occur.

Epiphysitis never reaches beyond the first stage without a certain invasion of the surrounding tissues, which become first œdematous and then thickened. Whether or no the cartilage itself increases in size, I am not able to say; it is, at all events, not impossible. After a time, an abscess outside the bone, independent of—that is, having no communication with the intraosseous abscess—may form, sometimes remaining close to the part (adjacent), sometimes reaching to a certain distance (neighboring). I am unable to account, to my own satisfaction, for a singular tendency which epiphysitis possesses to spread to the contiguous part of the opposite bone. For example, if the outer condyle of the femur be affected, the outer portion of the tibial tuberosity becomes after a time involved, and usually before the other side of the femoral epiphysis participates. Thus, also, inflammation spreads from one tarsal bone to another, so that we very rarely find one considerably inflamed without detecting, on anatomical examination, a like condition, but less advanced, in other contiguous bones. Such a phenomenon among smaller bones and joints is of course more easily accounted for.¹

In epiphyses or in short bones, which are still quite immature, the inflammatory process is considerably modified, constituting what I have been in the habit of naming to my class “nuclear epiphysitis.” In the earliest stage, the bony nucleus is alone hyperæmic, but afterwards the cartilage around it is also implicated; serum is effused between the one and the other, generally in spots here and there, sometimes more widely, and occasionally throughout. This fluid becomes, by the addition of leucocytes derived chiefly from the tissue-elements, turbid and milky, and slowly changes to pus. Extravasations of blood also take place in spots within the nucleus, or on the cartilage close to it. Where these effusions of fluid take place, the nucleus and the surrounding cartilage become separated from each other, the new surface of the latter being dendritic, rough, and generally vascular, while the shreds which hang from it float in the effused fluid. The nucleus itself becomes discolored, gray or greenish-gray, in small spots or in one large blotch; these spots generally break down into abscess-cavities. Either by conversion of the first effused serum into pus, or by suppuration of the newly formed bone, or by both processes, the nucleus is separated through a certain extent of its periphery from the surrounding cartilage. Sometimes, indeed, the whole osseous kernel is thus isolated, and when the cartilage is bisected, drops out of the cavity as a nut out of its shell.²

Now the pus thus lying in a cavity will not continue long to be quiescent. In one direction or another the cartilage becomes inflamed and ulcerates, and the abscess opens into the joint-cavity either by a large rent, or, as I think more often occurs, by a number of little channels. If this irruption of pus be almost sudden, violent synovitis, as in Mr. Brown’s case,³ or, if less explosive, a less violent but still acute joint-disease, ensues.⁴ When, as more often happens, an intra-epiphysal abscess passes more slowly toward the articulation, some inflammation of the joint-tissues precedes the irruption of pus; these are, therefore, no longer in the excitable condition natural to healthy synovial

¹ It is in great measure from tarsal bones which have been secondarily, and therefore less deeply involved, that I have been able to trace out the earlier phases of infantile epiphysitis.

² Of course, to make these observations on separate cases of joint-malady would be impossible; a lifetime would not afford sufficient opportunities; but in the opposed joint-bones, and in the bones less advanced in tarsal disease, one finds examples of nuclear inflammation in all stages. In these I have discovered and traced out all the conditions above noted.

³ Clinical Society’s Transactions, vol. ix. p. 175.

⁴ Mr. Smith, St. Bartholomew’s Hospital Reports, vol. x. p. 190.

membrane, and resent the presence of pus but very slightly. Again, epiphysitis is often a remarkably slow affection, which, after months of more or less remittent pain, but of continuous swelling, may hardly reach beyond the stage of hyperæmia. It induces, however, by transmission through continuity, an equally chronic inflammation of periarticular and then of synovial tissues. The disease in these soft parts goes through the same processes as in strumous or fungating synovitis, but to him who will look for it, the point of origin will be quite apparent. If afterwards pus form in the bone-end, and ultimately break either into the altered joint or into the neighboring tissues, very little or no additional action is provoked by the occurrence. But that part of the cartilaginous epiphysis which lies next the joint, becomes more or less quickly disintegrated, the intra-epiphyseal inflammatory products mingling with those of the synovial tissues.

If the inflammation arise in an older person, in whom the epiphyseal ends are more matured, the articular cartilage yields by one of two processes, both of which are generally present in different parts of the diseased joint. One process, simply ulceration from the free surface, such as is described at page 418, occurs where the osteitis is at some distance from the articular facet, and where the inflammation has spread to the cartilage by way of the soft parts and the synovial membrane. The other process occurs where the bone-inflammation lies very close to the joint-surface, and after a time softens and destroys those lamellæ and trabeculæ which uphold the articular lamella; the

Fig. 604.



Shedding of cartilage in osteitis.

cartilage and the gritty débris of that lamella then fall, or are pushed by subjacent granulations, into the more or less still persisting joint-cavity. Such pieces are often found lying in pus, or in new inflammatory tissue, with the sabulous detritus of the articular lamella still adhering on one side. If the inflammation and detachment have been rapid, the cartilage is quite healthy; if slower, it is in a certain stage of fatty degeneration. Thus, to recapitulate: Inflammation of an epiphysis, or of a short articular bone, culminating pretty rapidly in abscess with or without central necrosis, gives rise, when it passes quickly to the joint, to suppurative synovitis. When it passes to a lateral surface, it causes inflammation of the periarticular and synovial tissues of a subacute character, with extra-articular abscess, localized, or at least more severe, on one aspect of the joint. A slow epiphysitis,

with softening and intraosseous granulation, but either without abscess or with abscess of slow formation, is followed by a slow, fungous synovitis. The evident enlargement and change of form in the primarily affected bone-end marks the starting-point of the disease until it is far advanced.

When, however, the soft constituents of the joint and the other bones have been for a long time diseased, it not only is impossible, but also unnecessary, to distinguish the structure wherein the disease may have commenced; for at this late period, when granulation-tissue, abscesses, and other results of inflammation are found in the bone and the synovial tissues, equally diffused and equally active, the whole organ is reduced to exactly the same state as that which is left by a strumous synovitis, as already described (page 421).

When an epiphysis suffers from inflammation, its growth is arrested, such arrestation continuing even long after the disease has ceased. This result is the same whether the epiphysitis have been primary, as in the cases now under consideration, or secondary, as in synovitis, and whether the action have been suppurative, or have merely ended in sclerosis.¹ By these means the limb-growth, as far as it depends on the function of that particular epiphyseal junction, is checked: thus, if the child be quite young when the disease begins, and the arrest of growth last a considerable time, very considerable inequality of limbs results—an important matter in the lower extremities. I have lately had under my care a boy, aged 10 years, who, when four months old, suffered a fall upon the knee, which was much inflamed for some weeks, and the movements of which have been somewhat restricted ever since. The femoral condyles on the affected side look quite babyish in comparison with the others; they are:—

On the right, in breadth . . .	$3\frac{3}{4}$	inches; left . . .	$2\frac{7}{8}$	inches.
“ “ in circumference . . .	$12\frac{1}{4}$	“ “ . . .	$10\frac{3}{8}$	“
Length of right limb . . .	$27\frac{1}{2}$	“ “ . . .	$26\frac{1}{4}$	“

A similar though not so marked a difference is the usual result of early epiphyseal disease.

Thus far we have confined our study of the disease in question entirely to local changes; but we must now go on to consider certain systemic conditions, and certain morbid changes of internal organs, which, either produced by the same diathesis or induced by the wasting effects of local malady, very frequently accompany the later stages of joint-disease.

Reasons have already been given (at page 411) for regarding certain low and very persistent inflammations as strumous. These inflammations tend to produce granulation-tissue of so sluggish a description that, though it may spread into and invade a large neighborhood, and disintegrate a large area of previously healthy structures, it does not tend to any higher organization, but rather to remain merely embryonic, with a proclivity to certain forms of degeneration. Among these are the fatty, always combined with or closely followed by suppuration,² and more rarely by caseation. Also, it is probable that in a certain number of cases tubercular degeneration occurs; but this condition is, I believe, far more rare than is commonly supposed. It is at the present day very much the fashion to speak of tubercular disease of bone as though it were a common condition, and yet crude, gray tubercle has not been found, as far as I know, in bone; and there is a vast difference between tubercle of bone and the tubercle of inflammatory products. It is, when as

¹ It appears that very slight inflammations may have this result; thus, we find occasionally a short limb that years ago had been hurt by a blow or fall, which laid the child on the couch for only a few days. There is, I think, reason to believe that a chronic inflammation of the diaphysis tends rather to lengthening.

² I must recall to the reader's memory the distinction between fatty degeneration of old granulations and primarily fatty osteitis.

a rarity it occurs in this latter form, viz., as tuberculization of indolent granulations, that the so-called tubercular osteitis occurs. But great caution must be used before those non-vascular spots, formed by compressed endothelial cells surrounding two or more giant-cells, are accepted as tubercle, for all minute districts of granulation-tissue, which in their growth become deficient in vascularity, are apt to develop giant-cells, and these in their expansive growth starve and compress the endothelial cells lying in their immediate vicinity, thus producing a globular (on section a circular) envelope to the central large cells.

But the strumous is very closely related to the tuberculous diathesis, and it is only too common to find that patients suffering from strumous joint-maladies will, after a time, develop tubercle of the cerebral meninges or of the lungs. Such a sequence may be interpreted in one of two ways: The first, that a given patient is affected with struma, and therefore is prone to a closely allied disease, and that by a wearing and exhausting joint-affection the patient has been reduced to a condition especially favorable to the production of tubercle. The second, that a certain bacillus has produced the primary tubercle, and that its spores are afterwards transported from its original site to the lung or the membranes of the brain. The former of these interpretations is a view which has been common in the profession for very many years, and nothing material is here to be added on the subject. The latter encounters many difficulties. No peculiar bacillus has, as far as I know, been discovered in tubercular organs to which air has no access; and it would be very difficult to imagine—probably impossible to prove—that a development of tubercle in one part could call forth tubercle in another not directly connected with it by circulation, lymphatic or sanguineous; but there is no difficulty in seeing that the constitution which develops tubercular deposit may do so at two places simultaneously or consecutively; or, indeed—and this lies nearer to my views—that the diathesis which produces strumous malady in structures not prone to tuberculosis, may cause tubercle in organs prone to that deposit. In other words, there is at present no proof of infection from person to person, nor from one organ to another and a distant organ; but there is plentiful proof of constitutional and hereditary tendency to certain forms of disease. Hereditary tendency is a characteristic entirely different from what we know of diseases produced by bacilli or microzymes.¹

The fatty and suppurative degeneration of inflammatory tissues, if extensive and long continued, leads to a morbid condition of certain abdominal organs—liver, spleen and kidneys—often called amyloid, a term which should be forgotten, but better named lardaceous. This change, being a sequela of long-continued suppuration, when large in quantity is more apt to follow on suppuration of bony tissues, which is always prolonged, than on that of soft parts, which is usually less enduring. Dr. Wilks and Dr. Grainger Stewart² both associate it with deep-seated cachexia, such as is produced by strumous or syphilitic disease, particularly if it affect the bones, and it further appears to be owing, as Dr. Howship Dickinson³ has shown, to a diminished alkalinity of the blood, produced by draining away of certain salts with the

¹ At page 413 *et seq.*, some account was given of Dr. Schüller's experiments in injecting various tubercular—or supposed tubercular—materials into the blood of animals in whom a knee-joint had been severely injured; the experiments seem to prove that the joints are hardly to be rendered tuberculous by any such process. At the same time some doubt was indicated as to the truly tubercular character of all the aniline-dyed bacilli found in sputa, or in the pus of phthisical cavities. Those paragraphs were written, as was the text above, before the appearance of Dr. Spina's researches and of his excellent criticism of Dr. Koch's work. To these I would refer the reader.

² Gny's Hospital Reports, 1864 and 1865.

³ Med.-Chir. Trans., vol. 1. p. 39. 1867.

pus; a chemical but rather barren report¹ shows, in respect to the liver, that the lardaceous organs "are considerably deficient in potassa and phosphoric acid, while they contain an increase of soda, chlorine, and cholestérine;" and "that the deposit producing the peculiar condition may be called *albuminoid*, although the proportion of nitrogen it was found to contain appeared to be somewhat lower than that which exists in albumen."

This albuminoid matter is deposited in various parts of the different organs named, chiefly along the course of the minuter vessels, and therefore especially where function is most actively carried on. For instance, in the Malpighian bodies and the tubuli of the kidney; in the lobules of the liver, intermingling with the hepatic cells; in the Malpighian corpuscles of the spleen. Hence, it early interferes with, and, after a time, abolishes, the function of the particular glandular element in which the deposition occurs;² the effects therefore produced vary according to the organ attacked. Often, however, two of those named, and less frequently all, are involved; yet whether one or more be thus diseased, mal-nutrition, cachexia, and increasing anæmia are the invariable results.

Special note must be taken, however, of the effects produced on the secretion of the kidneys by this disease, viz: albuminuria, and the appearance in the sediment of certain casts called hyaline, which consist of a very transparent, highly refracting material, often lined externally with an imperfect covering of epithelium, which, having adhered to the "*albuminoid*" cast, has become detached from the tubule, the lining of which it really is.

Nevertheless, it must not be assumed that these changes are, unless they have overpassed a certain point, necessarily fatal; if suppuration, the cause of this disease, can be summarily stopped, lardaceous changes will retrograde, even rapidly, if the patient be still young.

SYMPTOMS.—The joint-ends of long bones are in adults rarely inflamed. When thus affected, the disease is generally rheumatic or traumatic. Syphilitic osteitis usually attacks the shaft. Short bones, as those of the carpus or tarsus, as also the ends of phalanges, may be inflamed in adult, and even in senile, life.

The first symptom in articular osteitis is a dull, heavy pain, which is worse at night. In young children this symptom is translated into limping, and disinclination to move the limb; also into sleeplessness or restless sleep, with waking up to cry. On examination, no change may be perceptible to the eye, and it may be difficult at first to ascertain which is the affected joint;³ but care in examination will eliminate error. Palpation of the affected part will discover a certain change, hardly as yet an enlargement, of one bone constituting the joint; for instance, at the knee, accurate comparison with its sound fellow will verify a slight swelling of the deepest soft parts, beneath which the bone will be found, not increased in size, but altered by a subtle change of form; the normal depressions being less marked, and the elevations not so prominent, but broader.

After a time, the enlargement becomes more real, and perceptible to the eye, but is still confined to one part of the joint, or rather a little above or below the actual joint; that is, the place where the two bones are in contact. There

¹ Transactions of Pathological Society, vol. xxii. pp. 1-12. London, 1871.

² In regard to the liver, fatty are very frequently, though by no means always, mingled with lardaceous changes.

³ Students and young practitioners are so often cautioned against attributing the knee-pain of hip-disease to a malady of the knee, that the contrary error sometimes occurs, and I have more than once known treatment to be directed to the hip, when after-events showed that a femoral condyle was the affected part.

are about that part one or two places where tenderness may be found, and perhaps some obscure fluctuation, often false, may be detected. All this time, and the condition may remain almost unchanged for months, the joint itself, that is, the synovial membrane and cartilages, will be quite healthy, and if the osteitis be cured, no articular immobility will result. It is advisable that the surgeon should measure the different parts of the joint; the tape often gives no information, but a pair of small callipers, easily carried in the pocket, will greatly help him in verifying the increase of size, let us say, of one condyle, of a part of the tibial tuberosity, of the lower end of the ulna, etc. Moreover, the instrument will tell him if one part only of the joint-end be enlarged. To exemplify the method of using this instrument, let it be assumed that the inner femoral condyle is the suspected part; the first measurement may be across the whole lower end of the bone (that is, from the outer face of the external, to the inner aspect of the internal condyle); if this be found larger than the corresponding part on the other limb, the condyle itself can be compared with its fellow by measuring, first, from close to the inner edge of the patella to a point just inside the inner margin of the semi-membranosus muscle; and secondly, from above downward, viz., when the knee is bent at right angles, from a spot just in front of the insertion of the adductor magnus, to the angle where the inner, non-articular face becomes the horizontal joint-facet. A source of fallacy may be presented by a certain tumefaction of the soft parts, but an educated touch will be able to estimate the amount of this thickening, and subtract it from the difference given by comparison of the diseased with the sound limb. By these or similar means, at other joints, a fairly accurate judgment as to the reality and amount of bony enlargement may be obtained.

About this period of the disease, the skin over the affected part assumes a peculiar aspect; it is white, looks as if tightened over the underlying parts, and has a lifeless or bloodless appearance. The swelling is not by any means sufficient to produce stretching, and, unless the condition be caused by derivation of blood from the superficies, or by some condition of nervous supply, I know not how to account for the phenomenon.

After an interval, the skin over the affected part becomes reddened, generally intermittingly; at first it often pits slightly on prolonged pressure; a point may even appear to fluctuate, and this usually indicates that the osteitis is very near that particular spot. At this stage, muscular phenomena (contraction followed by contracture) usually set in, and starting pains are soon after added. The time when these symptoms commence is quite uncertain; it depends on the proximity of the abscess to the articular facet. It may be that the neuro-muscular phenomena precede any implication of the synovial membrane, or any redness of skin, or they may come after such affection has commenced; but under either condition, they are, in respect to the synovial disease, very early; that is to say, when disease has commenced in the synovial membrane, greater morbid changes of that tissue take place before starting occurs than when disease commences in the bone. Also, in many cases, subluxation slowly sets in much sooner than it does in mere synovial malady. However slowly the perisynovial tissues respond to the inflammation, they do, after a time, unless the epiphysitis cease, reply by a process of proliferation and granulation, whereby the whole membrane becomes thickened and enlarged. Pus may be formed in the joint and in the extra-articular tissues, even before intraosseous abscess has opened in either direction; thus the symptoms of granulating synovitis are superadded to those above described, but nevertheless they are not quite like those produced by disease primarily synovial, for the enlargement of the periosteal and osseous tissues at the original site of the malady still marks the pre-eminence of osseous dis-

ease; the greater preponderance of neuro-muscular phenomena also plainly indicates the true nature of the malady.

When the osseous wall gives way outward, and the inflammatory products mingle with those already in the soft parts, abscesses, either deep or approaching the surface, give their characteristic fluctuation, while the skin reddens over those which are superficial. But if the bone cavities open into the already granulating and suppurating joint, no definite change of symptoms marks the occurrence. Occasionally the intraosseous disease is quickened, and a central necrosis, or an abscess without necrosis, forms in the epiphysis, and may with more or less rapidity pass towards a surface; the approach of the inflammation or abscess towards some bone surface other than the articular, is heralded by a spot of persistent tenderness on pressure, as well as by redness, while the subjacent tissues are swollen, soft, and boggy. A still nearer approximation is marked by pitting, and afterwards by obscure fluctuation. If the inflammation or its products extend towards the joint, hitherto but little affected, marked exacerbation of the articular swelling, much fluid in the cavity, increased pain, and especially more violent starting pains, will denote the time of its coming near to the cartilage. The actual entry of pus into the cavity will give rise to no symptoms if the joint be already considerably inflamed; indeed, since intraosseous pressure is relieved by the discharge of matter, some of the most distressing symptoms will for a time subside. After forty-eight hours, however, there will supervene, if much pus have entered the joint, a peculiar appearance of the part. The skin becomes swollen and sodden-looking, with superficial pitting; it is very white, save in one or two broad wavy lines, or in foliaceous pink patches. Such a joint is much influenced by the pressure of the limb's weight, so that as it lies on the splint or cushion it is flattened on its upper and lower aspects, and broadened out at the sides. The patient's health is much depressed; he is weak, hectic, and pale, with a white, sodden tongue. The thermometer is but little above normal in the morning, but rises two or more degrees in the late afternoon and evening.

Certain cases present symptoms which are rather enigmatical to the practitioner who is not considerably versed in this class of diseases. The patient may have had considerable pain in a bone-end, and some slight swelling of the soft parts over it, combined with stiffness of the joint, restless nights (waking and crying out, if a child), starting pains, and evidence of pain on moving, or, at least, disinclination to move the joint. But with all this there may be no articular swelling, save the spot over the bone-end above mentioned. Suddenly, or all but suddenly, this condition will be unpleasantly interpreted by the appearance of a violent synovitis, which, if not at first suppurative, very soon becomes so.¹ The symptoms denote that the osteitis has begun very near the joint surface; perhaps that necrosis has even involved the articular lamella; that the cartilage has suddenly given way, and that pus, with other inflammatory matters, has been poured into the joint.

The slow form of disease first depicted, and also the latter, more rapid malady, if the first violence be overpassed, leave the soft and hard constituents of the joint granulating and suppurating; abscesses open to the surface, and sinus-mouths, crowned with large granulations, perforate the skin. These sinuses and abscesses differ a good deal in their appearance, according as the osseous disease is a caries or a necrosis. In the case of *caries*, the pus is thin, irritating, and copious; the sinus-mouth, some distance from the seat of disease, is crowned by large florid granulations, of a peculiarly brilliant color, and bleeding very easily; the skin around is tightly drawn, of a bluish shade,

¹ For symptoms see p. 396.

and looks thin; the sinus is tortuous, whence there may be difficulty in touching the diseased surface with a probe, and when the carious surface is touched, a fresh flow of blood ensues. When the disease is *necrosis*, the

Fig. 605.



Osteal joint-disease; epiphysitis affecting whole lower end of femur; caries.

pus, not large in quantity, is nearly laudable; the granulations surrounding the sinus-mouth are large, flabby, and not very brilliant, and do not bleed with extreme readiness; the skin around is normal; the sinus is short and fairly straight; the diseased bone does not bleed on contact with the probe. A peculiarity of the abscess-openings in children, which is, I believe, due to the slow formation of pus, and which I have been accustomed to connect with fatty osteitis, is detachment of the skin for a long distance around the opening. The same thing occurs to the skin over suppurating tubercular glands of the neck. One may pass a probe introduced through an opening of, for instance, $\frac{1}{4}$ inch circumference, and let it travel under the greatly thinned skin in a circle extending on all sides from $\frac{1}{2}$ to $\frac{3}{4}$ inch away from the margin of the wound. This skin, detached from subjacent parts, continues to get thinner, until it becomes perforated with little pin-hole openings; and

ultimately it may give way altogether. But the skin over the abscesses of fatty osteitis does not become discolored for a long time; that over tuberculous glands is reddened much sooner.

Now, the joint which has become diseased by way of the bones, and by secondary affection of the synovial membrane, comes in this stage to be in the same state as one which, having been the seat of synovial disease, has now also involved the bones; and the one malady, like the other, may tend either to further destruction or may retrograde. The signs and symptoms of either course are identical with those described at page 426 *et seq.* With them are combined certain alterations in and dangers to internal organs, and thus to life; but as long as these remain absent, the joint-trouble in itself does not kill; and even after severe local ravages all morbid action may cease, leaving not disease, but the results of disease, behind. There is no doubt that a vast number of persons recover from very severe joint-affections. In institutions with which I am connected, many inmates are under my supervision with one, sometimes with two, limbs scored with old abscess-scars, very numerous, near to and distant from the marred and generally ankylosed joint, and indicating an amount of past disease which I, without such experience, and influenced only by what I see in hospital, should have thought could hardly be survived. The moral is instructive, and will be again referred to very shortly. But the surgeon must not be content with considering the joint alone; he must frequently go further, and examine into the state of lungs, liver, spleen, and kidneys, to detect the earliest signs of tubercular or of lardaceous disease. To the surgeon experienced in these matters, additional morning and evening irregularity of the temperature, night-sweating, a red flush on the cheek (often only on one), bounded by a clear defined edge,

evening cough, and morning expectoration, will indicate the *lung* as the special seat of danger.

The symptoms of nascent *lardaceous disease* are very much more obscure; they, of course, vary with the organ attacked. The one symptom common to all, is increased loss of health, visible cachexia, and considerable wasting. If the *liver* be affected, to this must be added an icteroid tinge, but not jaundice, with occasional constipation varied by colliquative diarrhœa, clay-colored and highly offensive evacuations, and a manifest increase in the size of the organ, the margin of which is evident far below the ribs. The symptoms of *splenic* affection are more obscure, but a certain yellowish-brown or clayey change in the complexion, together with a dry, rough, furfuraceous skin, a peculiar pallor, and slight yellowness (a maple-yellow, not the almond-orange tint of jaundice) may lead to the suspicion that the spleen is implicated. It is not usual that any enlargement can be detected until late in the disease. Lardaceous changes in the *kidneys* are detected with ease and certainty; they lead rapidly to one form of albuminuria, which, however, in and by itself is not diagnostic; but by placing some of the sediment under a sufficient power of the microscope, hyaline casts are readily detected. These bodies are so peculiar that he who has once seen them can never mistake any other object for them. They have the form of the *tubuli uriniferi*, and generally on the surface, here and there, are either epithelial scales or the mouldings of their lines of separation; they are, and by this they will chiefly be recognized, highly refracting. Naturally, they are somewhat various as to size, according as they come from the larger tubules near the hilus, or from the smaller ones close to the cortex, and from the neighborhood of the Malpighian tufts. When in albuminous urine such casts are found, it may be concluded that the albuminuria is due to lardaceous change; but I have some reason to believe that a kidney already advanced in desquamative nephritis may subsequently become lardaceous. This observation may be important in certain cases.

TREATMENT.—In the early stage of chronic articular osteitis, the same general treatment may be used as that recommended for strumous synovitis. Tonics and judiciously-adopted alteratives have certainly their advantage. Among these, movement of the sound limbs and exercise in the open air play a large part. Even when, on physical examination, enlargement of the bone-end only can be detected, and while yet the soft tissues of the joint are free from swelling, rest of the part must be enforced; and if the disease affect the lower extremity, a splint which fixes the diseased joint and leaves the other free, is to be applied and maintained in position both day and night,¹ the patient being encouraged to remain in the open air and take as much exercise as possible. In the mean time, blisters, allowed to remain on the limb a little longer than in fungating synovitis, but allowed to heal at once, and frequently repeated, are very valuable. In some cases benefit appears to result from the actual cautery, the iron being drawn in one thin line across the inflamed spot. The skin on each side of the intended line should be well protected with two or three layers of wet adhesive plaster. A Paquelin's thermo-cautery, heated to whiteness, is the best instrument. After cautious removal of the plaster, the burn should be dusted with flour or oxide of zinc, and covered with cotton-wool. The burn thus made is singularly painless; indeed, if joint-pain be pretty severe, and especially if there be starting, great relief is obtained. The disappointing part of the method is, that in many cases, after the immediate inflammation of the skin-burn has ceased, the

¹ The sorts of splint advised are described and depicted at page 430 *et seq.*

symptoms are apt to recur; the inconvenient part is the presence of the sore and subsequent scar. In certain cases the treatment is certainly useful; the difficulty is to distinguish these cases beforehand. It appears to me that those cases benefit most which are marked by severe starting pains before any synovial disease begins, and which show an early tendency to intraosseous suppuration.

The oleate of mercury, 5, 10, or 20 per cent., according to the age of the child, may be painted on the swollen part every day, or every other day, so as slightly to redden the skin; the iodide of potassium ointment, or strapping with the plaster of mercury and ammoniacum, or of iodide of lead, may be employed. Pressure is of little, probably of no use, but somewhat powerful counter-irritation, such as may tend to direct hyperæmia to the skin, appears to divert it from and so relieve the bone. The great necessity of treatment, however, is to keep the joint at rest, to prevent either weight or muscular pressure, and to do this by some means that will allow to the child exercise and plenty of fresh air.

If in spite of these measures the joint-end continues to be inflamed—if it swell more, and especially if it assume somewhat of a conical form, while starting pains supervene, or, if they be already present, increase—we may conclude that the intraosseous or intracartilaginous parts are in a state of tension, are very possibly progressing towards suppuration, or have already begun to suppurate. Under these circumstances, it evidently becomes the surgeon's duty not to wait upon events, nor let the pus choose its road, perhaps into the joint, or otherwise into dangerous parts; but he should take the initiative, and by opening the outer case of cartilage or bone, guide the diseased products in a safe course. In considering the application of this method, the surgeon must of course be well aware that, even though the symptoms may indicate a certain point for perforation, he yet may not find an abscess, occasionally, no doubt, because none is present, and occasionally, because though present, it has been missed.¹ By having pierced the bone, however, even when no abscess exists, benefit and not injury results; the signs which the surgeon has before him indicate intraosseous pressure, and it is only a little more or a little less gravity of the symptoms that can indicate whether that condition is due to the presence of pus, or of effused serum, or merely to hyperæmia. In either event, the relief by what I have termed "paracentesis ossium," relieves that pressure which otherwise would result in suppuration, perhaps in necrosis. To perforate and miss an abscess is a mischance, which the surgeon must do all in his power to avoid; the result is not direct injury, but absence of expected benefit to the full extent desired; nevertheless, some diminution of tension is produced, and I have twice seen abscesses that had been missed, open in five and eight days respectively into the perforation. Means whereby the mishap may as much as possible be prevented will be described immediately. When, therefore, the symptoms indicate intra-epiphyseal tension, the surgeon has to ask himself if they are sufficiently decisive to call for interference; and, if so, whether the spot most clearly marked be in such a situation as to be attainable without injury to the synovial membrane, even though he may have to make the paracentesis somewhat oblique. If the patient be so young that the epiphysis or short bone is chiefly cartilaginous, a tender, swollen, and red point of skin, when such appears, marks a spot opposite the site of chief intra-epiphyseal disease; if subsequently, or in more acute cases, the whole neighborhood be red and swollen, it may safely be concluded that all the nucleus opposite that side of the limb is inflamed. Thus in either case it is impossible—given an

¹ Holmes, *Surgical Treatment of Children's Diseases*, p. 427.

accurate knowledge of infantile anatomy—to miss the nucleus and the seat of tension. But if general swelling of the epiphysis, with the other signs of tension, be unaccompanied by any distinctive change in the condition of the skin, operation is the more imperative; since the disease is, in all probability, extending either towards the joint or towards the epiphyseal junction, the former direction being the more usual.

Having determined to operate, the surgeon, bearing well in mind the line of attachment of the synovial membrane, makes beyond that territory a crucial or T incision down to the bone, from which he peels the periosteum with a raspator. (This, however, if the part be still cartilaginous, is usually impossible.) The flaps being retracted, he introduces the head of a small trephine, and removes to such depth as he may consider sufficient, a plug of the bone, which is carefully to be examined for any softening, induration, or such new surface as may be the wall of an abscess cavity. The opening, too, must be carefully watched for any outflow of pus; if this come freely, the cavity, although it probably has been sufficiently opened, should be examined, since another cavity may exist, or since a sequestrum may require removal. If only an oozing of pus or serum occur, a probe should be used to find the situation and direction of any channel. If no morbid fluid escape, exploration must be carried further. I have found the best instrument for this purpose to be a rather fine and well-tempered brad-awl, which may be used with simply a thrust, or, if necessary, in the usual way by rotation. It may be passed from the original perforation in various directions, being carefully watched for signs of pus, and from time to time withdrawn, that the fluids adhering to it may be examined; any abnormally hard part of bone is to be suspected, since localized abscess is very usually surrounded by osteo-sclerosis. Any softened portion must be gouged away, or otherwise removed.

If the epiphysis be still quite immature, the best instrument for performing the cartilage is a gouge of suitable size, whose side edge also is sharp for $\frac{1}{3}$ or $\frac{1}{2}$ an inch; a plug of the cartilage down to the osseous kernel is easily removed with this instrument. The condition of the escaping fluid, if any, must be noted; the nucleus is to be examined with the probe, and any softened or otherwise diseased portion removed; sometimes even it is necessary to take away a very considerable part, and occasionally I have removed the whole as a sequestrum. Mr. Eve, indeed, recommends that in all cases the inner parts of considerably-inflamed epiphyses should be removed after the manner called "*évidement des os*," leaving, that is to say, only the outer shell.¹ I have not found this to be necessary, unless the whole be either necrosed or carious; removal of the parts which are in that condition, together with relief of tension, is sufficient to allow the rest to recover.

After the operation the wound is to be well mopped out and cleansed with an antiseptic—boroglyceride is preferable to carbolic acid, which is too irritating, and is of itself enough to set up some osteitis—when a drainage-tube, big enough to fill the perforation, is introduced to the depths of the wound and there retained. I prefer to syringe through it, and leave it *in situ* until it is pushed out by the granulations which in a few days arise in the bone, and which, if the disease have been efficiently removed, fill the cavity in from a fortnight to six weeks, according to its size.

While wishing to avoid any exaggeration, I must be allowed to state from my experience that many cases thus treated get well, which, if left alone, would, according to all appearances, result in very severe disease, with all its dangers and evil consequences.

But a certain number of cases, although undoubtedly osteitic, do not show

¹ British Med. Journal, vol. ii. 1882.

such signs of tension as would induce most surgeons to perform paracentesis,¹ and some few cases, in spite of the operation, still progress badly; this occurs chiefly when delay has been prolonged until the soft parts of the joint have become diseased, or else when the osteitis has been unfortunately situated close to the articular facet. When such continued disease, from whatever cause, occurs, the treatment resolves itself for a time into the maintenance of rest and of good position, while, unless the limb be too painful, exercise in the open air is enforced.

An abscess near the joint should be treated as soon as it is plainly detected, and best by free incision; a probe or a finger may then be passed into the cavity, and an examination made. A circumscribed caries, if accessible, may be dealt with by the gouge; a sequestrum of similar character may be removed, even although not yet loose, if it be within reach of the instrument. If a part of it constitute some large portion of the joint-surface, I would the more insist on this practice, as affording freer exit to intraosseous pus and allowing earlier anchylosis, which, for a joint thus involved, is the best means of cure.

In all other points, save that of ascertaining and thus actively treating the condition of the bone, the management of the latter stages of articular osteitis and of strumous synovitis are alike, and I would refer for details to page 428 *et seq.*; but it must be noted that the prognosis of articular disease commencing in the bone is, even in these late stages, worse than that of disease primarily synovial.

If the osteitis have attacked one or more small bones, such as those of the carpus or tarsus, a device for removing the débris of *caries necrotica* may be employed, and sometimes with excellent results. In such cases, abscesses will have resulted in leaving either on one or both sides of the part, one or more sinuses, into which a probe being passed, impinges on carious or necrotic bone. The gouge is not as efficacious here as with joint-bones of larger size; but a mesh of prepared tow, oakum, or tenax, may be drawn through the diseased parts, only taking care to wound no important vessel or nerve, and to secure, where the fabric passes through the skin, openings wide enough to let the mesh lie quite loose and free. Every few days the big tenax seton is drawn a little through; in a short time it entangles and brings away larger or smaller pieces of bone detritus, and after a time, when all have been removed, healthy granulations arise from the sound bone left behind. In carrying out this method, it is very important to pass a seton along each and every diseased track, and to leave it in place until all the carious bone is removed, as otherwise the morbid condition will recur. During this treatment, one of the splints already described—and, to my mind, Dumbrowski's is the best—is to be applied, and the patient is to be allowed to go about.

If suppuration, with caries or necrosis, still persist, the surgeon has several very difficult problems wherewith to deal, depending upon the condition of general health and of the internal organs; he must frequently examine the lungs, and ascertain the presence or absence of cough, hectic, night-sweating, etc.; the size and condition of the liver and spleen must be constantly inquired into; and the urine must be from time to time examined for albumen and hyaline casts.² If this examination afford no ground for anxiety, a careful estimate must be made of the tendency to get well, or of the possibility of inducing such a tendency, as also of the probable condition of the limb which

¹ I resort to the operation whenever epiphyseal swelling is marked and starting pains commence early

² See pp. 475 and 479.

may be left behind, when, the disease being overpassed, healing has been completed. Upon the data thus gathered must be founded the decision as to the advisability of amputation or excision.

But if, on the contrary, the examination reveal commencing lung mischief, a very careful estimate of its stage, and of the possibility of its retrocession, must be formed. A certain, possibly only a small amount of bronchial or perilobular change can undoubtedly be repaired if the source of suppuration be at once eliminated. Conclusive signs of tuberculization, and *a fortiori* of the existence of cavities, would of course debar us from any operative measures.

In regard to lardaceous disease of abdominal organs, I am able to speak very positively, for several cases have shown me that a liver, even so enlarged that its edge lies below the level of the umbilicus, will recede when the flow of pus is at once prevented; even a spleen large enough to reach half-way to the middle line will diminish under the same circumstances. In order to appreciate the state of the kidneys, examination of its secretion should be made on three or four consecutive days. If all the casts be of the largest size—if there be absolutely none of the smaller sizes (and several specimens should on each occasion be examined¹)—and if the albumen in the test-glass do not amount to more than one-quarter of the depth of the fluid, we may operate with fair hopes of success.

But these remarks apply only to young patients; to those under twenty-five, still more to those under fourteen. Moreover, they take for their basis the postulate that suppuration can be at once stopped; hence, for such cases amputation is the one operation to be advised, and excision is as a very general rule inadmissible.

III. ARTHRITIS DEFORMANS.

This name is preferable to rheumatic gout, or chronic rheumatic arthritis, because it does not imply a pathological relationship, which is by no means proven; the term “rheumatoid arthritis” may be less objectionable, because the disease is in some of its symptoms—but only in some, and not in its anatomy—a little like rheumatism.

The disease chiefly attacks elderly people, though occasionally exceptions to this rule occur, which are traceable to some febrile disease, or, and these are the most frequent exceptions, to a disturbance or suppression of the catamenia. It has a considerable predilection for the male sex, and is most common among the poorer classes, who are badly fed, and much exposed to vicissitudes of weather.² It is generally multarticular, but not infrequently unarticular, and then it usually attacks the hip-joints of old men. The malady, then commonly called “*morbus coxæ senilis*,” has frequently a traumatic causation. Some of the patients are prematurely old, depressed in health, and feeble; others are rosy and cheerful, with excellent appetite, and with quiet sleep. In some, the urine deposits plentiful lithates; in others, though the fluid is too acid, no such deposit takes place. Some persons are attacked at a perfectly definite moment of time, and the malady runs pretty quickly up to a certain not very advanced point, the further steps being slow. In other persons it commences very insidiously, and its progress from the

¹ The smallest casts sink, as a rule, quickest, and lie at the lowest part of the sediment.

² Haygarth, the first who noticed this disease (*Nodosity of Joints*. London, 1805), made a directly contrary statement, namely, that it most commonly attacked women of the wealthier class. Brodie described it as very prone to attack the little-worked and over-fed upper servants of great houses; he evidently did not properly distinguish the malady from true gout.

very commencement is quite gradual. Again, in certain patients, the peri-articular tissues (to judge by symptoms only) seem for a long time the only parts affected; in others, the proper constituents of the joints become earlier involved.

MORBID ANATOMY.—From the last sentence it may be gathered that all parts of and around the joints are concerned in the disease; and certainly this is the case, although the most marked and conspicuous changes fall upon the bones. Given succinctly, the alterations of the different tissues may be thus described:—

Changes in the Peri-synovial Tissues, Ligaments, and Tendons.—The first two are in the beginning simply inflamed and thickened, and the disease may, as above indicated, remain for a long time confined, or almost confined, to these parts. As time goes on, the thickening increases and induration occurs, the tissue being converted into a material like coarse fibro-cartilage. In other parts of the same tissue, the contrary effect, namely, considerable thinning and absorption occur. The difference appears to depend upon whether the particular part is relaxed or kept on the stretch. Afterwards the thickened part becomes in many cases ossified, not merely calcified; true bone, though rather imperfect, is formed, usually beginning at the line where the fibrous capsule is attached to the bone, and spreading thence in an arborescent or foliaceous manner, sometimes in blotches or plates. Occasionally, even nearly the whole tissue may thus be converted into a sheath of bone. In tendons and their appendages the chief changes fall upon the synovial sheath, the inner surface of which becomes coated with a fine dendritic growth, which gives it a velvety or fur-like aspect.

The synovial membrane is at first red, from hyperæmia, but afterwards paler, because the vessels are much concealed by thickened tissue. Around its osseous attachment, very coarse fringe-hypertrophy is strongly marked. The growths are at first thick and strong, and are clubbed at the ends by the development of nodules, some of which have passed through the stage of cartilage and have become bone.¹ As these bodies increase in size, the fringe attaching them becomes thinner, and forms at last a mere thin thread. When the bony plates in the capsule are well developed and thick, some of them press on the membrane, and, after a time causing its absorption, protrude through it, so that they form at last part of the boundary wall of the joint. During this hyperplasia, the tendons or ligaments that lie within the joint, *e. g.*, the long tendon of the biceps, the round ligament of the hip, the crucial ligaments of the knee, partake in the same condition; their interfibrillar constituents proliferate, separate the fibres, and afterwards more or less absorb them; they become detached, first at one end, the ligamentum teres from the digital fossa, the cross ligaments, as a rule, from the tibia. When the intra-synovial part of the bicipital tendon is absorbed, it gains a fresh attachment in the bicipital groove lower down, unless prevented by large osseous changes to be hereafter described.

In the *cartilages* the changes are very peculiar and multiform: hypertrophy, atrophy, ossification, fibrillation, and fatty degeneration. The localization of these different pathological acts to different parts is as follows: where there is no or but little mutual pressure, hypertrophy takes place; where the pressure is considerable, there is atrophy. Thus, the edges of cartilages grow out in the direction of their surface, or, as we might say, centrifugally. For example, at the head of the femur the edge of the incrusting cartilage grows from the edge of the half sphere towards the trochanters, so that if this pro-

¹ See the sections on Hydrarthrus, and on Loose Bodies in Joints.

longation were perfect and uninterrupted, the added cartilage would form a tube surrounding the neck of the bone,¹ while a similar outgrowth from the edge of the acetabulum would inclose that tube in yet another one. This growth at the edge of cartilages may be termed marginal hyperplasia; the outgrowths rapidly ossify. But mingled with this process, lines and intersections of fatty degeneration and atrophy occur, in such wise as to divide the added parts into irregular masses of somewhat square, hexagonal, or rounded shape, which thus come to form nodosities, or larger craggy conglomerations about the margins and surroundings of the joint ("additamentary bones").

But in the mean time, wherever pressure occurs, atrophy of the cartilage prevails; in some parts by fatty degeneration of the cells, enormous exaggeration of the corpuscles, and peculiar, coarse fibrillation of the hyaline substance. In other parts, the cartilage seems to disappear simply by encroachment of the bone from the deep surface. The outcome of these difficult and complicated changes is, however, quite simple, viz., disappearance of the articular cartilage; the bone is left bare, while by the marginal hyperplasia the amount of contact-surface is largely increased.

The *bones* undergo very remarkable changes of constitution and of form, produced by an intermixture of hypertrophy and of atrophy. Both these actions are of two sorts—interstitial and dimensional—producing respectively condensation or rarefaction, and increase or decrease of size. The combination of these two acts is influenced by pressure-friction, which produces by its irritant effect interstitial hypertrophy, and by its wearing effect dimensional atrophy. In other words, all hardened or condensed portions are undergoing "*usure*" or wasting, while all outgrowths and dimensional enlargements are at the same time rarefied. The former are all situated where the juxtaposed bones press and rub on each other; the latter on the margins of articular surfaces where no pressure exists, until the outgrowths from the different bones come into contact.

This sort of induration is not quite the same thing as an osteo-sclerosis, produced by an ordinary osteitis, and consisting of an orderly increase of the bone elements within a given space. The induration of arthritis deformans is, on the contrary, produced by the deposit of lowly organized bone-salts, in the form of an effusion among, rather than of assimilation into, the bone-tissue imparting to the structure an appearance like porcelain, whence the name "*porcellaneous deposit*." Mr. Quekett long ago pointed out the mechanism of this change, and of the high polish which such surfaces receive. In these places, "I found," he says, "that the bone was more than usually dense, and that there was an almost total absence of Haversian canals, which made the bone more dense; this led me to speculate on the cause of this porcellaneous deposit. Recollecting that the French polisher (when he wishes to give a fine polish to rosewood, mahogany, or any other woods which have an open grain) first fills up the pores in the wood with some wax or resinous material, and then polishes, whereby a fine lustre is obtained, etc." To this account I must add that the deposit is quite superficial, reaching hardly $\frac{1}{10}$ of an inch below the surface, and that it never is found save where two bones rub together. Thus, the friction which afterwards produces the polish, causes by its direct irritant action the effusion of the lime-salts. Furthermore, these spots of polished, porcellaneous structure are here and there formed of cartilage that has been ossified and partly worn away; here and there of the somewhat hypertrophied bone. Wherever and however formed,

¹ The hyperplasia is never thus equal and uninterrupted on all sides; but we will leave the matter so for the present, pointing out in future what it is by which the hyperplasia is interrupted and modified.

the continued friction wears the surface with a rapidity that is not a little remarkable, and the joint-cavities become greatly altered in form, partly by this, but partly and chiefly by another agency, which will be mentioned immediately. Such attrition leaves its very evident marks in lines of polished ridge and furrow, always running in the direction of movement, namely, in straight lines in hinge-joints, as in the patella, femur, and tibia, at the knee; in cycloidal curves in enarthrodial joints, as at the hip and shoulder.

Thus, to epitomize the above: wherever friction occurs, there we find interstitial hypertrophy with dimensional atrophy, that is, a somewhat solidified bone gradually wearing away; but where no friction and no pressure take place, there we find the direct contrary—interstitial atrophy, with dimensional hypertrophy. In other words, the bone proper (that is, not bone of new formation), in places subject to neither friction nor pressure, becomes porotic, the Haversian canals enlarging to the size of wormholes in old mahogany. At the same time, the marginal hyperplasia above described produces new masses and outgrowths, first of cartilage, and then of bone, the juxtaposed surfaces of which, when they come into contact, form a new portion of articular surface outside and beyond the old and normal joint-area, becoming also, at the points of touching, polished and porcellaneous. Such outgrowths greatly deform the joint, and together with the effects of friction above described, may very considerably modify the shape of the part. Thus bony heads, normally globular, become mushroom-shaped, or more rarely conical; hollows which, in their healthy state, are but slight concavities, as, for instance, those on the tibial tuberosities, are transformed into wide and deep depressions; while cavities, naturally deep and cup-shaped, like the acetabulum, may be widened into broad and shallow saucers. Nor is it contradictory of this pathology that the forms produced vary in different cases very considerably, since any peculiarity of posture or of movement, assumed for the avoidance of pain, may greatly modify the situation of pressure and of friction, and therefore the locality of atrophy or hypertrophy.

Let us take, as an example of the effects produced by this singular admixture of hypertrophy and atrophy, such changes as frequently occur at the upper part of the femur. A first sight of the dry bone gives the idea that the neck has wasted and become bent down, so that the head, somewhat enlarged, has become sessile on the shaft between the two trochanters. What really happens is, that all the head, save a little at the lower part, is atrophied and worn away, while by marginal hyperplasia the neck is enlarged, so as to be transformed into something that looks like a misshapen head.

At certain joints, less surrounded than the hip by muscular structures, osteophytic outgrowths are very strongly marked; those which have been already mentioned are frequently craggy, rough, and outwardly uneven, while those from opposed bones that come in contact, receive a porcellaneous polish, and at the same time greatly interfere with or entirely prevent mobility. A joint, such as the knee, may thus become entirely motionless, but not by ankylosis, which in this disease is exceedingly rare.

In considering these very remarkable osseous changes, it appears to me impossible to suppose that the malady originates in the synovial membrane, and is then transferred to the bones; perhaps (though it would be contrary to our experience of other joint diseases) it may simultaneously invade all the articular structures.¹ For my part, I believe it to be in its origin osseous, and that the synovial affections sometimes appear before any bony change can be detected, simply because these affections are occult, like other interstitial changes of bone. When we consider that neighboring processes become in-

¹ Hueter (*Klinik der Gelenkkrankheiten*) calls the disease Polypanarthritis.

volved, and even may come to form a part of an abnormally exaggerated cavity—for instance, the coracoid and acromion processes may become a part of the morbid shoulder-joint—we can hardly believe in the synovial origin of such wide alterations situated a long way from that membrane.¹

SYMPTOMS.—Early detection of this disease is very important, since in its later phases it is peculiarly intractable. Although chiefly a disease of old age, it may, nevertheless, attack young persons. More especially should the sort of pains described below be regarded with suspicion when they affect young women whose catamenia are scanty and irregular. The malady may also follow acute rheumatism at a long interval. It may, when uniarticular, be due to traumatism, afterwards spreading to several joints. Exposure to cold, insufficient food, long-continued overwork or mental depression, residence in a damp atmosphere or in an ill-protected building, may be causes of the disease, and may lead to the interpretation of symptoms. But, on the other hand, we find persons well fed and housed, with no possible anxiety, who have never had an illness and never committed an imprudence, who are rosy, cheerful, and digesting and sleeping well, and yet who are crippled by arthritis deformans. When the disease arises from some definite cause, such as a chill, or a distinct attack of rheumatism, the symptoms are clearly marked and rather abrupt, viz., pain and stiffness in one or more joints, with periarticular—and, in the joints, intra-articular—effusion. The case looks like a mild attack of rheumatism. The urine, too, is generally loaded with lithates, but there is no diaphoresis; the skin, indeed, is dry and without acid smell. If there be any pyrexia, it lasts but a day or two. When no distinct causation can be traced—sometimes, even, when this can be done—the commencement is much more obscure; perhaps there is only in one or more joints a slight, hardly noticeable, morning stiffness, which goes off after an hour or two, but slowly becomes more persistent, and affects other parts.² I have known this form to be described as “creeping rheumatism.” One case, which arose after sudden cessation of suckling, was described to me as “milk rheumatism.” During rest, the early phases of the malady are painless; but at a later period, if some of the larger joints are involved, starting pains are troublesome, though never severe. Any movements are more painful after prolonged rest, than when motion has been persevered in for some time. The affected joints may occasionally be the seat of effusion, which in the smaller articulations is slight and transient, but in the larger ones, especially in the knee, is often considerable and persistent. Some alteration in shape is nevertheless perceptible, but less in the joint itself than in the bone immediately adjacent, which becomes irregularly nodose and gnarled.³ For a long while no further changes in the joints themselves are perceptible, but the progress of the disease may be traced in a remarkable flaccidity of the muscles, very different from their state in other joint-affections. When the malady attacks the hip, the buttock hangs peculiarly loose, and almost pendulous; when the

¹ In the above account I have given the result of much independent study of a large number of specimens, availing myself also freely of the works of earlier investigators, namely, R. Adams, “*Treatise on Rheumatic Gout* ;” R. W. Smith, on “*Chronic Rheumatic Arthritis* ;” and Canton, “*Surgical and Pathological Observations*,” a little work from which much information may be gleaned.

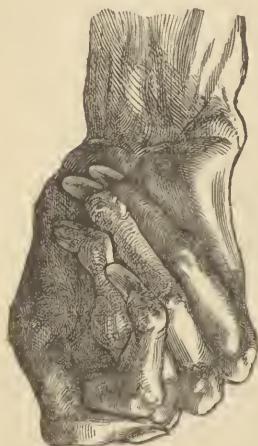
² A gentleman of my acquaintance, aged 67, began with a little stiffness in the morning about the joints of the fingers, afterwards the ankles, and then the knees; subsequently, almost all the joints were involved, and the painful stiffness became continual.

³ My experience is, that although the period of synovial effusion is uncertain, it does not begin until the stiffness has lasted some time, often till after nodosities have appeared. In this sequence the knee is sometimes an exception, considerable synovial effusion being much earlier in it than in any other joint.

knee, the same may be noticed of the thigh. With this flaccidity, rapid wasting is also combined.

Gradual immobility becomes more and more decided, and at the same time crepitus, distinctly bony and occasionally very rough, can be perceived; in some cases this is so harsh that it can be heard at even a distance from the patient; shortly afterwards, abnormal mobility can very often be detected.

Fig. 606.



Arthritis deformans of hand.
(After Canton.)

Although space will hardly permit details as to the peculiar deformation of each joint, yet of two it may be desirable to speak more particularly. Of all parts the wrist and hand are the most frequently affected, probably because the most exposed. These extremities are also of use in diagnosis as offering a certain characteristic, and that often when they are by the patient supposed to be exempt. This characteristic is adduction of the fingers. At the metacarpo-phalangeal joint, the index is most affected, and often previously to the others, so that it tends to overlap the middle finger on its dorsal aspect. A little after this the back of the wrist comes to have a hollow look. The radius and ulna, but more especially the latter, which is much enlarged, project. Then follow those enlargements and uneven projections on the knuckles which caused Haygarth

at first to speak of "nodosity of the joints." The first phalanx of the thumb becomes strongly flexed on the metacarpus, while the inter-phalangeal joint is straight. After a time are slowly developed very singular distortions and positions of the fingers, which render the hand utterly useless.

The hip may be affected together with other joints; the diagnosis is then simple, being aided and guided by the generally crippled condition; but when that articulation is involved alone, there may be some ambiguity. For instance, it has happened to me more than once that a man having received a blow or suffered a fall on the hip, has declared that previous to the accident he could walk perfectly well; the position of the limb and the crepitus have caused the condition to resemble fracture of the neck of the thigh-bone; but the wasted and flaccid muscles, with certain other symptoms, have negatived such a diagnosis. Afterwards I have elicited from the patient's friends that he has walked lame for years. Therefore, and because histories are not always reliable, it is very important to be able to distinguish accurately the uniarticular disease—the *morbus coxæ senilis*.

The limb is rotated outwards, divergent from its fellow, and shortened—the shortening being in part real, but also in great measure produced by elevation of the corresponding side of the pelvis. The thigh can generally be drawn a little downward, and may also be slightly pushed up again; also, by placing the fingers deeply behind the trochanter, the thumb in front, the neck and head of the bone will be found to have some abnormal mobility backward and forward.¹ These symptoms might all depend on fracture of the neck of the thigh-bone. The disease, however, is distinguished from that injury, by the fact that although in the former voluntary motion is considerably re-

¹ These symptoms depend upon enlargement of the acetabulum, the usual lesion of arthritis deformans at this place. There are, however, it should be known, a few cases in which the cavity is deepened, and in which the osseous outgrowths from the edge of the socket lock the neck in very firmly; and in such cases the last-named symptom would be absent.

stricted, it is not entirely abolished. The patient can lift the limb a little from the bed; he can rotate it slightly outwards, and also a little inwards; the buttock and thigh are not merely flaccid, but are also wasted. The patient, too, can, if he please, put some weight on the limb, though with pain. When the history is quite reliable, the slow advent of lameness in the disease is entirely different from the onset of the lameness in injury; but when a man with arthritis deformans of the hip has suffered some traumatism, and is also malingering, the above marks will afford the means of diagnosis.

We will take up again the conditions of the disease as it progresses in several joints; patients thus suffering may, nevertheless, continue in very excellent general health, but the joints already affected become gradually more immobile, while other articulations are one after another involved. In some cases, the patient is at last incapable of moving almost every limb; fortunately the temporo-maxillary articulation is rarely involved. But I have seen several patients in whom almost every joint of the body has been so stiffened that they have had to be moved from bed to chair and back again, being entirely unable to assist themselves in the least degree.

TREATMENT.—The treatment of arthritis deformans is by no means satisfactory, more especially when the disease is already pretty firmly established; hence, early recognition is of great importance, although sometimes from its very nature impossible. In other cases, however, the presence of the malady, commencing in a subacute form with joint-pain and a certain pyrexia, together with very acid urine, depositing, perhaps, the red sand, may be suspected, and such cases may be advantageously treated with the alkalies or neutral salts. Aperients, but not purges, should be used, and the diet regulated, but not always in the same direction. When the patient, feeding largely on animal food, takes little or no exercise, we should adopt a treatment directly opposite to that which is required when the disease occurs in the poor and under-fed. But the condition of system is essentially one of debility, and all remedies, both in the subacute and chronic forms, should be prescribed in accordance with that view of its etiology. Tonics therefore, as a very general rule, are to be advocated. Iron is not well borne by the digestive system; but quinine, either as a solid or dissolved by means of citric acid, or, if this be not tolerated, the extract of cinchona, is useful. But arsenic is probably the most valuable of such medicines, and in many cases appears to exercise a retarding effect upon the disease. I believe that I have seen benefit from small doses of the perchloride of mercury, given occasionally for short intervals. Guaiacum, combined with ammonia, appears most useful when the affected parts are cold and clammy. Also valuable are certain mineral waters, especially those that, like the Woodhall Spa, contain iodine or its salts; the waters of Bath, Buxton, Harrogate, Vichy, Aix, and Carlsbad, are likewise useful.

The *local treatment* is to vary according to the condition at the moment. The subacute and painful commencement or interludes, are best treated by rest; if the pain be not severe, mere lying in bed will be sufficient, but if any particular joint be peculiarly painful, a light splint may be applied. If there be inflammatory symptoms, two or three leeches may be employed; but compresses steeped in hot water, or in a solution of bicarbonate of potassium, ten grains to the ounce, with a like quantity of dilute hydrocyanic acid, are better, as being less debilitating. Local applications of belladonna also give relief; blisters, too, may be employed, especially in such cases as are marked by considerable effusion.

When the malady is chronic throughout, as also in the chronic intervals

of fluctuating cases, rest is to be avoided. The patient must be directed to take as much exercise as he can without over-fatigue, thus promoting porcellaneous polish of the bones, and preventing the encroachment of osteophytes so near those which spring from the opposite bone as to fix the joint altogether, or beyond the amount absolutely inevitable. It is to be confessed that when the disease has reached this stage, all that art can do is merely palliative; the surgeon must direct his efforts to spare for his patient as much power of movement as possible.

SYPHILITIC AFFECTIONS OF JOINTS.

Syphilitic affections of the joints are very rare, and are among the latest manifestations of the virus. They assume two forms, arising either from gummatous deposit in the perisynovial tissue, or from periostitis of the articular end, which, when it occurs, is usually consecutive to periostitis of the shaft.

SYPHILITIC JOINT-DISEASE FROM PERISYNOVIAL GUMMATA.—This variety, which is the less common of the two, only arises when gummatous products are plentiful in external parts, and in the viscera; the disease is rather an extension from the surrounding fibrous tissues of inflammation, caused by deposit within them of gummatous material, than a primary affection. But it must be confessed that little opportunity for anatomical study of this condition has as yet been afforded. The well-known case of Lancereaux¹ is the only record of pathological investigation of this subject that I can find; it is unfortunate that the period during which the patient was under observation is not mentioned, nor is any account given of the condition of the joints during life. After death, numerous gummata were found in various parts of the body, notably in the liver.

Both the femoro-tibial articulations were enlarged, and each contained more than a glassful of a yellowish, turbid serum. The synovial membranes, thickened and at the same time injected, were studded with several small pseudo-membranous deposits. On the left side, a yellowish false membrane united the two layers of the synovial membrane; on the right side, the synovial bursa of the rectus femoris was not changed. The articular surface of the left external condyle was eroded, and, as it were, ulcerated at one point. The articular cartilages of both patellæ were eroded or ulcerated; there was a velvety condition over half their extent; but these changes were secondary, only the chief lesion affecting the fibrous tissues of the joint. On the right side, a part of the ligamentous tissue attached around the tibia was changed into a uniform, grayish-yellow, elastic mass, about an inch and a half thick at the median line. The mass resembled in many respects the morbid products met with in the liver, being like them formed by a gummy deposit. Except the fibrous band representing the ligamentum patellæ, there were found in it only some fibrous septa, which appeared to divide it into several small tumors. The left joint was similarly affected, except that the cushion of fat behind the patella had not disappeared as completely as on the opposite side. The fatty mass had retained its normal appearance at the upper part; an anatomical examination of the articular gummy masses showed a structure identical with that of the gummy masses in the liver.

By comparing the results of this autopsy with the records of other cases, we may evolve a picture of the disease which is plainly to be understood. The disease is essentially chronic, and is occasionally remittent; it does not appear to affect any joint but the knee; it may be double or single, and is

¹ Treatise on Syphilis, Sydenham Society's Translation, vol. i. p. 255.

not accompanied by fever.¹ The effusion is clear or opalescent, sometimes fibrinous. When the synovitis has lasted long, or has returned several times, the cartilages, as in all synovitic disease, may be secondarily affected, and the distension may loosen the ligaments. But as the above autopsy and certain clinical observations, to be hereafter mentioned, show, the presence of gummous tumors or thickening is that which essentially gives character to the disease.

Symptoms.—The symptoms of syphilitic synovitis, independent of bone-affections, are not, it must be confessed, very conclusive when taken alone, and the diagnosis must rest largely upon the presence of other syphilitic manifestations. At the same time, it must be pointed out that a person with syphilis may also have a joint-disease which is not produced by that affection, although perhaps a little modified by the poison.² Nevertheless, there is, as Richet³ pointed out in 1853, and as the above case by Lancereaux shows, a syphilitic malady of the perisynovial and synovial tissues, having somewhat peculiar symptoms. The patient may or may not have at the period of joint-affection a plainly marked manifestation of syphilitic disease,⁴ but when the case is fully investigated, a scar, or, at least, some history of previous syphilitic trouble, can, in all cases, be discovered; for arthropathies are, as already stated, late lesions, more especially those arising from gummata. The knee or knees are distended with fluid, the enlargement being preceded by a sense of fulness and tension; but, at the time of effusion, they are remarkably free from pain, though feeling weak and unsteady; there is very little tendency to that contraction of the flexor muscles, which is so marked a symptom in other acute joint-diseases. This important point is deserving of further elucidation: the ordinary chronic hydrops articuli is not accompanied by any marked pain, muscular contraction, or fever; but that malady is less rapid in its first invasion, and goes on slowly, gradually, and non-intermittingly increasing. The syphilitic perisynovitis, in its most characteristic form, attacks the part suddenly, usually causing considerable pain. The disease frequently disappears, or becomes greatly mitigated, to return with like symptoms again and again; or, if it do not intermit, the pain at all events ceases nearly or entirely; the effusion appears to have no relation to the pain, the patient being able to walk with little trouble, though easily tired. The joint may be subjected to passive movements without pain; but, in some cases, active movement is not quite painless. The limb bears complete extension more easily than flexion. By palpation, a certain thickening of the periarticular fibrous tissues may be perceived; this is not evenly spread over the joint, but appears in the form of somewhat hard, yet doughy, lumps and plates, extending some distance beneath the skin. If the malady have been allowed to continue for a long time, the relaxing effect upon the capsule is the same as in non-syphilitic, chronic hydrarthrus, producing a certain amount of abnormal mobility. In much-neglected cases the cartilages become eroded. The diagnosis, even though in the most characteristic cases all these symptoms be present, can hardly be perfectly certain until the effect of antisyphilitic treatment has been observed.

¹ Syphilitic affections, however, have been of late shown to be accompanied by an evening rise of temperature. See a report on the temperature of syphilis, *Clinical Society's Transactions*, vol. iii. p. 170. It is probable that were the cases referred to in the text to be observed at the present day, that condition would be noticed.

² It is one of the results of any specialism that its professors are apt to draw many alien things within the confines of their particular sphere. I must confess that some maladies described as syphilitic appear to me very doubtful examples of syphilitic disease.

³ *Mémoires de l'Académie de Médecine*, tome xvii. p. 251.

⁴ Richet's first patient had at the time no other mark save scars of chancre and bubo; his third had buccal aphthæ and enlarged testicle; the condition of his second was more strongly characterized by condylomata. Of Verneuil's two patients, one was more evidently affected than the other.

SYPHILITIC JOINT-AFFECTIONS WHICH ORIGINATE IN BONE-DISEASE.—These may lead, unless their true nature be quickly discerned, to more serious results than the synovial malady. When syphilis attacks the osseous system, it most commonly affects the hard structure; certainly, when any limb-bone is involved, the shaft is more commonly chosen than the joint-ends. Moreover, syphilis of the spongy portion of a long bone is commonly a later manifestation than nodes, etc., on the tibia or cranium. The lesion takes the form of a gumma, which, on the surface, is circumscribed in a patch or patches beneath the periosteum, and occupies the more superficial layers of the osseous tissue; in the cancellous structure it is more commonly, though by no means constantly, diffuse.

From either of these starting points, the joint may become involved; from the former, the malady spreads by continuity to the synovial tissues, the result being a syphilitic hydrarthrus like that above described, but somewhat more recalcitrant: from the latter arises a malady of far deeper gravity, involving the cartilages, and causing them to ulcerate or to be cast off into the joint. The effused fluid, not large in quantity, is therefore largely mixed with tissue-débris and leucocytes; it is puruloid rather than purulent, for true suppuration of the joint is unusual. This form of the disease tends to terminate in either false or true ankylosis.

The *symptoms* of this malady vary somewhat according to the different modes of attack above described; but both forms have this in common, that they are preceded by the well-known pains in the bones which are so characteristic of syphilis (osteocopic), aggravated at night. If the gummatous deposit be on the surface, the patient will point out the seat of chief pain, and the surgeon will readily feel the soft, nodular enlargement; then, as the disease involves the peri-articular tissues, he will readily detect the localized lumps and patches overlying the joint (described above), and will thence have no difficulty in diagnosis. If, on the other hand, the gummatous lesion be in the interior of a joint-end, the osteocopic pains may not be accompanied by any distinct enlargement outside the bone, nor are the synovial tissues of necessity involved until a later stage of the arthropathy; indeed, it happens occasionally that the cartilages are pretty severely affected before any joint-swelling is observed. Other symptoms, however, should call attention to the locality, namely, difficulty on movement, a sense of weakness in the joint, and, not unfrequently, abnormal mobility. The disease, although chronic and slow in its course, has a sudden commencement, and is excessively painful during the night, but much less so during the day; there is but little tendency to flexion; passive movements, until the cartilages are ulcerated, are not, while active movements are, remarkably painful. When a mild articular osteo-syphilis has been preceded by vague and wandering pseudo-rheumatic pains, not uncommon in syphilis, the diagnosis between this malady and a localized rheumatic affection is difficult; but in the latter disease the joint is red in the beginning, effusion is more manifest, the pains are less uneven throughout day and night, and the urine, more markedly acid, contains a greater quantity of urea; the fever is of a different sort, not the peculiar one of syphilis.

Lastly, osteo-syphilis is accompanied, and frequently preceded, by loss of health, anæmia, skin-discoloration, and other signs of cachexia.

TREATMENT.—The treatment of syphilis by appropriate remedies has already been sufficiently discussed;¹ it need only be said here that such later manifestations as those now in question yield more rapidly to iodide of potas-

¹ See Vol. II. page 462.

sium than to other antisyphilitic remedies, and especially does this remark apply to such maladies as commence in the perisynovial or bursal tissues. Also, it is to be borne in mind that constitutional syphilis confers upon its subjects great tolerance of iodine. Such patients are not only able to take, but even flourish and get fat upon, such quantities as a drachm, or even occasionally on three drachms, of the salt per day. Nor does it appear to me that less than half a drachm in the same period has any effect, either on the disease or on the patient. I cannot speak in quite the same terms of this remedy in the form of disease which brings with it gummatous formations; iodine, though still valuable, exerts less manifest influence in these cases, and, if the patient be debilitated, it should be combined with a tonic, and more especially with arsenic.

The synovial or perisynovial form of joint-syphilis, thus treated, will get well in from three to six weeks, if at the same time rest by means of splints be enforced; if much intra-articular effusion exist, pressure, and in severe cases puncture also may be added. But as in all manifestations of constitutional syphilis, recurrence is very common. The syphilitic arthritis resulting from bone disease (not from mere periostitis) is far more severe and more lasting. The same plan, with modifications in the constitutional remedies, must be employed. But the case must be watched, lest symptoms of intraosseous abscess should be overlooked. To pierce the bone merely on suspicion that a circumscribed gumma might be found, would be unjustifiable; but it would be equally unjustifiable to leave an abscess, syphilitic or otherwise, to open into the joint-cavity. It is to be remembered, however, that wounds of syphilitic persons heal, as a rule, badly and slowly; hence no paracentesis of the bone should be undertaken unless the signs of abscess are very unmistakable.

Under such medicinal management as above indicated, a large proportion of patients affected with syphilis may stave off or keep in abeyance the recurrent attacks of the malady, while during the intervals their health may be fairly good. As the disease wears itself out or yields to the action of drugs, the intervals become longer and more free from trouble, the attacks shorter and less severe. But occasionally patients are not thus fortunate; there are some who, in spite of antisyphilitic remedies and tonics, constantly get worse, so that, though there are exacerbations and mitigations, there are no longer any distinct intermissions. These patients are generally such as have been in the early stages neglected; more rarely, at the present day, overdosed with mercury; occasionally this obstinacy is due to a combination of syphilis with struma. Very frequently, and in all classes of society, aggravation of the disease is due to irregularity of life, and especially to overindulgence in stimulants, a fault to which the patient is disposed by the depressing influence and accompaniments of the disease. In these cases I have found great benefit to be produced by sending the patient to such baths as Harrogate, which as a sulphur spring is valuable, to the Sohlbad of Kreuznach, or to several waters in the Pyrenees, which, especially if there be a tuberculous complication, have frequently so far altered the conditions of the disease that, though not cured, it has become amenable to treatment.

Joint-disease, connected with hereditary syphilis, is only known in the form of syphilitic dactylitis; even this more usually commences in the shaft than in the joint-end of the phalanx. Nevertheless, it frequently spreads to the joint; indeed, always does so, if two contiguous phalanges be involved. It is typically a gummatous affection, and may even be taken as a type of the process described above. Sometimes it occurs in acquired syphilis.¹

¹ See Vol. II. p. 438; Keyes, *Treatise on Venereal Diseases*, p. 175.

HIP-DISEASE.

The very prevalent affection known as morbus coxæ, or hip-disease, generally attacks children between the ages of two and thirteen years, being most common between the fourth and eighth years. Although children without any traceable cachexia are occasionally affected, the disease has decided preference for those of strumous habit. Doubtless, in a certain proportion of cases, the malady is first set up by some slight traumatism; but in a very large proportion the attack is spontaneous.

The very deep position of the joint produces great difficulties in the thorough investigation of the disease, and these are increased by the oblique position of the femoral neck, which causes the arc of movement to be not in a straight line with the axis of the limb. The former of these two impediments renders the early detection of swelling or of fluctuation extremely difficult, or impossible; hence the particular locality in which the malady commences can only be determined, in any particular case, by contrasting or comparing the symptoms during life with the results of anatomical examinations of other carefully and fully recorded cases. In the following account I shall epitomize the collective results of many such studies, in endeavoring to bring the pathological phenomena into a connected picture of the disease.

Disease of the hip is not in its pathology so peculiar that its inflammatory affections can commence in structures which are never the starting-points of disease in other joints. Nevertheless, a great many writers have believed that this malady arose in the ligamentum teres. The cause of this error depends upon a physiological function of that ligament, and upon the fact that pathological investigation, as carried out by certain investigators, does not go the length of making sections of the bone. The head of the femur, except its lower part, is entirely epiphyseal, and, until after the eighteenth year, derives its nutriment solely from a vessel carried to the digital fossa by the round ligament. When this epiphysis is inflamed, as it very often is, the artery becomes enlarged; hyperæmia, and then inflammatory softening, shortly destroy the ligament itself, which, therefore, is found in the state so often reported—inflamed, swollen, softened, shreddy, or detached. The disease has not, however, begun in that ligament any more than disease of the knee or of the shoulder, when we find the crucial ligaments or the tendon of the biceps altered, can be said to have commenced in either of those structures.

Synovitis does, no doubt, occur at the hip; but I believe not very commonly, and, when it does so, it is, in my experience, a comparatively slight affection due to traumatism or excessive fatigue,¹ and rarely passes on to the stage of disease with exuberant, sluggish granulations, described already as strumous synovitis. The position of the synovial membrane of the hip, so well covered, and therefore so little exposed to changes of temperature or to direct injury, helps to shield it from some of the causes of that disease.

On the other hand, the bones are so circumstanced as to render them very liable to inflammatory attacks, which are very easily transferred to other constituents of the joint, because the Y-shaped cartilage joining the three portions of the innominate bone, and the whole epiphysis whence the head and neck of the femur are formed, are inclosed in the synovial area. At the former place a large part of the pelvic growth occurs; at the latter, an inch and a half or two inches of a large bone is formed.² Hence, the nutritive

¹ I here except the absorptive diseases described at p. 403 *et seq.*

² At birth, the neck of the thigh-bone is represented by a mere groove between the disproportionately large head and the trochanters.

hyperæmia of these parts must be very great, while the supply of blood to the epiphyseal head is simply by one long vessel—that in the round ligament. We accordingly find, at post-mortem examinations, or in moderately early resections, that while the synovial structures are not widely implicated, the bones are generally deeply diseased. The inflammation may attack primarily the acetabulum; a not very common, but a very bad form of hip-disease. It more frequently begins in the femur, either involving all the epiphyseal head, or commencing in, and for a long time confining itself to, the epiphyseal line.

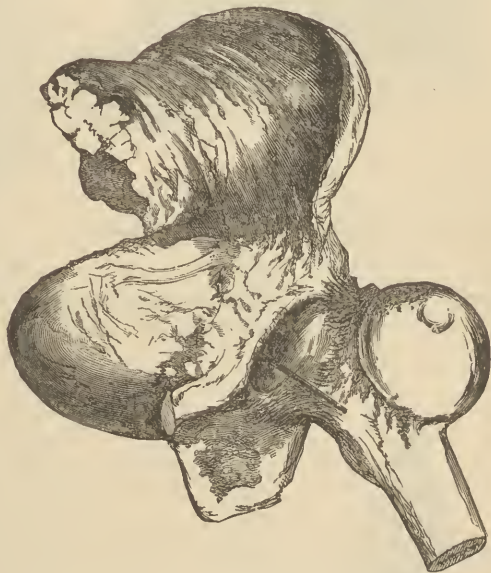
In the first case tumefaction and abscess form, not only within the acetabulum, but also on its inner wall; that is to say, within the pelvis, where they may occupy a large part of the true pelvic cavity, as was the case with the boy from whom the specimen here depicted was taken. The head of the femur is represented as turned back out of the cavity, which is perforated at its fundus, a bristle being passed through the opening and into the abscess, which, as big as an egg, nearly filled the true pelvis. The more usual commencement, however, is in the femur; and it may be well to remind the reader here that the epiphysis does not compose the whole head of the bone, a certain portion at the lower anterior and posterior part being formed by the diaphysis. Epiphysitis is the most common form of hip-disease; it very soon manifests itself with distinct articular symptoms, because the epiphyseal junction is entirely within the synovial membrane.

The result, when it runs its full course, is shedding of cartilage from the bone-surface, caries, and atrophy or wasting away of the head.

Frequently the inflammation does not attack thus the whole epiphysis; but primarily only the parts immediately adjoining the epiphyseal line, where, indeed, the formative process and consequent hyperæmia are most strongly marked. Thence, as in the annexed wood-cut (Fig. 608), the resulting caries may spread inward and outward on the head and toward the neck. The carious ulceration, having been cleared of granulation-tissue, pus, and débris, is well shown as penetrating to a considerable depth, while the effect of osteitis in rendering soft and breaking up the round ligament (page 494) is in this case exemplified.

But inflammation, beginning thus at the junction, may spread along the whole epiphyseal cartilage, as seen in Fig. 609. If this form of disease run its course, different terminations, according to the acuteness of the attack, will result. If, as is here represented, the inflammation be not very severe, and if it expend itself chiefly on the part adjoining the cartilage of union, the head will be separated, but gradually; it will have time, as in this case, to contract adhesions to the acetabulum, due to the synovial disease which the osteitis has set up. Such cases usually recover with diastasis—a subject which will be again referred to.

Fig. 607.



Intra-pelvic abscess from hip-disease. (Acetabular.)

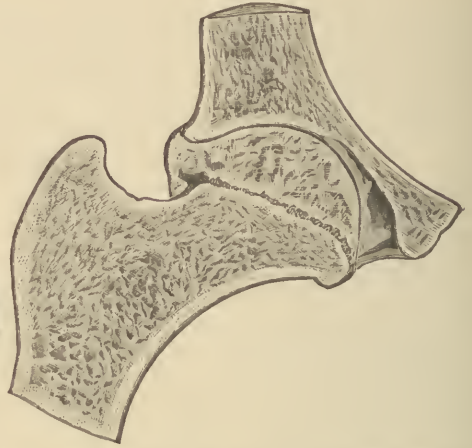
But if the original attack be more severe, causing rapid detachment of the epiphyseal head, and at the same time (as we have seen is the case) destruction

Fig. 608.



Caries of head and neck of femur from hip-disease.

Fig. 609.



Slow (gradual) diastasis and union of caput femoris with acetabulum.

of the round ligament, the isolated portion of bone must of necessity perish; it lies loose in the acetabulum, where it acts as a foreign body, and sets up,

or at the very least maintains, suppurative inflammation of a very severe character. Such a history is plainly to be read in the preparation here depicted; the epiphyseal head has become detached, and is represented as falling out of the acetabulum, while the margin of that cavity, and the dorsum of the ilium, even as high as the crest, are studded with osteophytes which bear witness to a very violent disease.

These are the modes in which morbus coxæ commences, so very generally that any other way of beginning is quite a rarity.

We will now go on to study the causes of certain conditions which the changes above described produce. As in other joints, so also here, osseous inflammation, of whichever kind above described, brings with it neuro-muscular phenomena; but the contractions have at this place very peculiar effects on the position of the limb, causing at first the symptom I shall call *fixity*, then *lengthening*, and afterwards *shortening* of the thigh. The first of these is simply due to rigidity of all the muscles passing from pelvis to femur. The

flexors, as almost always in joint-disease, are most affected; hence the thigh is, if not quite at first, at least very early, a little bent on the trunk. Then

Fig. 610.

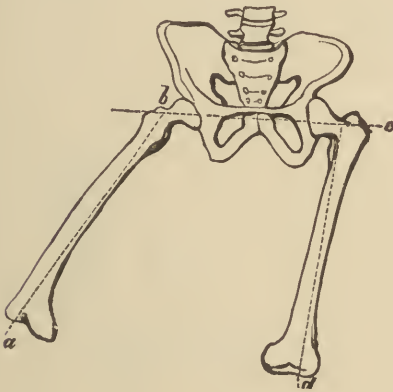


Rapid separation followed by necrosis of caput femoris.

the abductors become most markedly contracted, and the thigh is thrown outward, without, however, losing its flexion. Subsequently the abduction disappears, and adduction takes its place. The cause of this change is quite occult; at present we are without any clue even to an inference as to its nature.¹

Now it is upon these two positions of abduction and adduction that apparent lengthening and shortening of the limb depend; thus, abduction places the thigh at a certain obtuse angle with a line drawn between the two acetabula—for instance, at the angle $a b c$ (Fig. 611); but the individual will not remain in that posture, with the legs straddled wide apart, but will get them more or less parallel, still maintaining the angle of abduction; the only possible way of doing this is to let the pelvis on the affected side droop, as the one knee is brought to lie near the other; the skeleton then assumes the posture seen in Fig. 612; that is to say, the angle $a b c$ is maintained, the transverse

Fig. 611.



Abduction by separation of limbs.

Fig. 612.

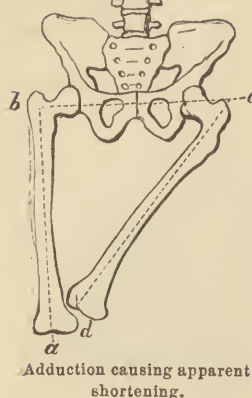


Apparent lengthening.

axis of the pelvis is oblique, one acetabulum lies below the level of the other, and therefore one knee is lower than the other. This is the “lengthening” of hip-disease; it is apparent only, no such thing as real lengthening being possible without either dislocation, diastasis, or fracture. Shortening is easily comprehended by similar observations regarding adduction; the rigid thigh is now placed at an acute angle with a line between the two acetabula, but again parallelism of the two limbs will be sought, and in order to gain this, and at the same time to preserve the angle, the pelvis is lifted; the line $b c$ (Fig. 613) again becomes oblique, but in the contrary direction; therefore the pelvis on the side of disease is lifted, and the knee of that side lies higher than the other. This is “apparent shortening;” it is that which occurs when the third stage of the disease is first reached; but a real shortening whose nature will be immediately explained is afterwards superadded. We must particularly note here that the abducted (lengthened) limb would, if measured from the spine of the ilium to the knee or malleolus, seem shorter than the other, because the whole crest is, by that posture, brought nearer to the trochanter, and therefore to the whole femur. On the other hand, because the

¹ In some cases, abduction appears to coincide with distension of the capsule, adduction with its subsidence; but these are mere occasional coincidences, and not, I believe, causally connected.

Fig. 613.



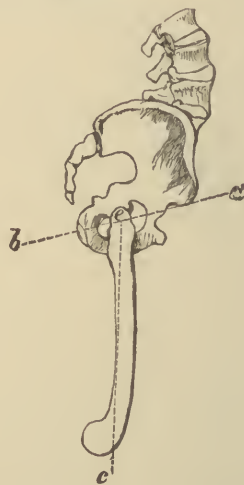
lying supine, and if the words horizontal and vertical be interchanged, the condition during recumbency will also be understood.

Fig. 614.



Flexion of thigh on pelvis.

Fig. 615.



Arching of lumbar spine to permit parallelism of limbs.

It is important to observe that until these positions have lasted long enough to enable the muscles to become contracted, they can be entirely corrected under anaesthesia.

These postures are produced by neuro-muscular phenomena, which have also certain other effects. Although the contraction of the flexors is greater than that of the extensors of the hip,¹ while the abductors and adductors alternate in their predominance, yet the muscles which pass between the pelvis and thigh are, speaking generally, in a state of contraction. The various rotators press the head of the bone inwards, while the longer adductors, the rectus, and probably also the surals, force that part upward. The result thus produced is a mutual excessive pressure between the upper back part of the caput

¹ Probably these latter are not contracted; certainly the chief extensor, the great gluteal, is flaccid.

femoris and the upper back part of the acetabulum; hence follows cartilaginous ulceration at those points—a *decubitus*, or pressure-sore—which is merely secondary, and which constantly occurs, even though the disease may have begun in quite another part of the joint. If this pressure continue, the resultant ulceration becomes deeper and deeper, and involves the bone of both joint constituents; the femoral head is then flattened down while the acetabulum is prolonged and hollowed upward toward the dorsum ilii. Hence arises part of the “real shortening;” the other part results from loss of growth, and, in severe cases, probably, also from decrease in length of the neck, consequent on disease about the diaphyseal aspect of the epiphyseal junction.

The causation of a certain early symptom, pain at the knee, must also be elucidated; it has been ascribed to various causes, but we may eliminate all except two, viz., distribution of nerves, and sympathy of the bone-ends one with the other. Of the former, it may be said that the sciatic and obturator nerves supply twigs to both joints; the anterior crural only occasionally does so. Either of these may, by irritation referred to a distant part, as is so common in nerve-irritation, cause a sensation generated in the hip to be felt at the knee. There is no doubt that the chief factor in this sort of knee-pain is the obturator nerve; it sends a considerable branch to the hip, and supplies that particular part of the knee to which pain, when distinctly localized, is most often referred.

Sympathy between the two ends of the bone has been proved by more than one observation.¹ I myself have in three instances found pressure on a displaced femoral head to produce pain at the knee. Many patients, when the thigh is pressed upward, complain of pain, not at the hip, but at the femoral condyles. It is to be observed, that these sympathetic bone-pains are always centrifugal—that is, they are never nearer to the trunk than the disease, but at a greater distance; the sympathy of the lower end is greater when the upper end than when the shaft is affected.

The course of the disease is, save for these points which arise out of its physiological anatomy, very much as in other joints; but certain other peculiarities may be noted, namely, that suppuration is probably more common at this place than elsewhere, and that dislocation when it occurs is usually complete. Of the former, it must be remarked, that abscess perceptible through the skin is not always intra-articular; that the pus often passes a long way between muscles and along fasciæ previous to pointing—hence, it may make its appearance at the front of the thigh, below Poupart's ligament, or behind the great trochanter; and that the locality is not always a sure guide to the place of formation. For instance, intrapelvic abscess may point at either of the two last-named spots. Pus formed at the lower part of the femoral head may come to the surface in front of the thigh, but more commonly appears behind the great trochanter, following the track of the external obturator muscle.

Luxation of the thigh does not mean that movement from its place which depends on the furrowing upward of the acetabulum, the head remaining in the altered socket; it means an absolute exit of the head out of the cavity, and its lodgment elsewhere. In certain cases dislocation is no doubt sudden, in others it is as certainly gradual. I have in resections found three times the head of the femur resting on the margin of the acetabulum, and marked by a transverse, semicircular, ulcerated depression, evidently the impression of that edge. When luxation is complete, the bone nearly always rests on the dorsum ilii. The only two exceptions that I know of, are a case in which I assisted

¹ See Wedemeyer, über Caries und Necrose. Gräfe u. Walther, Journal der Chirurgie, 5ter Band, 3ter Heft., S. 626.

Mr. Hancock to resect the hip, and in which the head of the bone was found on the pubis; and another, figured by Mr. Holmes.¹

A singular coincidence between hip-disease and phimosis was observed by me many years ago. It was so constant, that at last I noted every case of male hip-disease to which I had access. When one hundred had been recorded, I examined the documents, and found that in only six cases was there no phimosis; sixty-six had the affection severely, and twenty-eight slightly. I cannot consider this coincidence a mere chance, but think rather that this condition, so apt to induce frequent and long-continued priapism, has upon the infantile spinal cord a deleterious influence, which is reflected back, sometimes in mere awkward or stumbling gait, sometimes more severely, in hip-disease. Adverse criticism may, of course, find manifold difficulties and objections to this view of the case, but nevertheless the fact remains.

SYMPTOMS.—Occasionally cases of acute hip-disease occur. They are mostly, if not always, examples of osteo-myelitis; and it seems hardly desirable to add to the remarks which may be found in the section on acute osteitis. It may, however, be noted here, that sometimes during an ordinary attack very acute symptoms, but without any great pyrexia, may arise. These appear to belong to another category—namely, to partial luxation, the head of the bone pressing on the edge of the acetabulum.² But the vast majority of cases begin and continue throughout chronic, sometimes without, sometimes with a doubtful history of traumatism.³

First Stage.—This includes all that part of the disease previous to the advent of those postures which produce apparent lengthening and shortening. The symptoms are very significant; their correct interpretation is exceedingly important. They are: limping, joint-pain and tenderness, sometimes swelling, fixity of the thigh.

Limping is the earliest, or, at least, the first symptom observed; it is at first merely occasional, perhaps only noticeable after unusual fatigue; sometimes most marked at night, sometimes in the morning. Those forms of limping, which evidence great disinclination to place any weight on the limb, indicate a femoral origin. They are all marked by an unevenness of gait, the one step occupying a longer period than the other. After a certain time—occasionally only a few days, more often some weeks—the limp becomes constant, and, at the same time, the child begins to look out of health, worn, pale, and dark under the eyes; he sleeps badly and interruptedly.

Joint-pain is not always the cause of a limp, for, in many children thus affected, examination, unless unjustifiable violence be used, elicits no sign of pain; while other children, apparently not more severely affected, will scream when placed erect, or if the limb be moved. Most children with hip-disease sleep on the back, or on the sound side; a few on the affected side. When the child is old enough to define the place of pain, he indicates one of several spots: occasionally the outside of the ilium; sometimes a spot on the front, inner aspect of the thigh, a little below the apex of Scarpa's triangle; more often the knee; at this last place the pain may be very definitely localized in front of the inner condyle, or may be more vaguely spread over the whole aspect of

¹ Surgical Treatment of Children's Diseases, p. 466.

² In one of the three cases above referred to, I resected, for acute symptoms that had rather suddenly supervened, the head of a femur, deeply furrowed by the edge of the acetabulum, on which I found it resting.

³ Dr. Sayre considers hip-joint disease as usually traumatic (Lectures on Orthopædic Surgery, p. 231 *et seq.*). I can only say that such is not the fact in England, certainly not in London. In some cases the parents refer to a fall or injury, in this as in all other joint-diseases, but such histories are generally hunted up for the sake of finding a cause, and often are imaginary.

the joint.¹ In certain cases the pain is very early, previous sometimes to any other symptom save an occasional limp. A means of distinguishing referred pain from any produced by disease at the spot itself, is by making pressure, not with the finger-tips, but with the whole palm, over the sensitive part. This will increase the pain if there be disease at the knee; but if elsewhere, the pain will not be augmented, and may even be relieved.

Fixity of the limb is, of all symptoms hitherto recorded, the most important and reliable. I must strongly deprecate the old rough mode of investigation by forcibly driving the thigh upward against the acetabulum, and would inculcate all caution and gentleness. The fixation of the thigh may simply express itself by a limp, and, even when the patient is quite naked, the surgeon may be unable to ascertain clearly whether or no, in walking, the thigh moves on the pelvis. He will then, placing his patient supine on a sofa, and himself about the level of the patient's calf, take in hand the sound limb a little below the knee, and, while moving it in every direction, observe that the thigh moves freely in its socket, the pelvis remaining quite or very nearly motionless. He then gently grasps the other limb in the same way, and puts it, to a far less extent, through the like movements. If the hip-joint be sound, this limb will move like the other, and he may gradually increase the amount of motion; but, if it be diseased, the thigh will not really move on the pelvis. Watching the salient points of the latter, he will see, by noticing the spine and crest of the ilium, the pubis, and the tuber ischii, that the pelvis follows every motion of the thigh, and that the hip-joint itself does not move at all. The movement is partly at the sacro-iliac joint, partly of the whole pelvis on the lumbar spine. Especially difficult is abduction; all attempts to move the thigh in that direction very evidently impress considerable motion on the pelvis, while the adductor muscles, more conspicuously the adductor longus, are visibly and plainly contracted.

Second Stage, or Stage of Lengthening.—This comes on gradually, when the initial stage above described has lasted some weeks, or, in certain cases, some months. The patient must now be examined both in the erect and in the recumbent posture. In the former the patient stands on the sound limb. The foot of the affected side, only touching the ground by the toes, or very lightly by the whole sole, is in advance; the knee of that side is bent, and also in front of its fellow. The buttock is flattened and flaccid, and its lower fold hangs in a flabby, bagging manner on a level below the other. Therefore the depression behind the great trochanter is broad and shallow, or quite obliterated; and the part looks broader than on the other side. The pelvis is oblique, that is, the iliac crest of the diseased side lies on a level lower than the other, and in consequence the *rima natium* slopes from below upward and toward the side of disease, and the lumbar spine is curved towards that side. If the child be told to stand level, with the feet together and both knees straight, he will, if he bring the feet together, bend the knee; when told to straighten that joint, he will rise on the toes of the sound limb, and, by throwing back the other (diseased) side of the pelvis, protrude that buttock. By these manœuvres, one or all, he endeavors to increase the distance between the acetabulum and the floor; but they generally throw him out of balance, so that he sways about and seizes on any neighboring object. Many children will not make these efforts, but when urged to do so will cling to a support and scream.

The supine position shows that the child curves the body in a very pecu-

¹ The pain in front of the thigh may be very severe; I have had two patients who were in the habit of constantly pinching a fold of skin in that place, which they said relieved the pain. An unusual seat of pain is the inner side of the thigh, at the origin of the adductor longus. I have now under my care a young gentleman who has never complained of any other pain.

liar manner, so that the middle line, which runs from the centre of the pubes over the umbilicus and xiphoid cartilage to the supra-sternal notch, instead of being straight, is very much curved, with its convexity towards the side of lengthening. If the disease be, as far as this stage is concerned, advanced, it will be found impossible to put the body and limbs in a straight line. When having to do with a child or boy, it is convenient to go to the bottom of the couch, take a foot in each hand, and, looking between, move them to the right or left, until the four points above named of the trunk are seen to be, if possible, in a straight line. In older girls the same end may be attained, with less exposure, by passing a cord under some light garment on the lower part of the abdomen, letting one end be held on the centre of the episternal notch, and the other between the malleoli, the pelvis or the feet being shifted from side to side as required. When the body and limbs have thus been placed in as straight a line as possible, the relative level of the malleoli must be compared.¹

But in most cases, especially in young children, it is impossible to get the xiphoid cartilage, umbilicus, and pubic junction to lie under this cord, or in a straight line; they persistently remain on one side of it (diseased side). Now, if a finger of each hand be placed on the anterior iliac spines, and a line between them be imagined, or if, from one to the other, a second cord be stretched, it will not intersect the former string at right angles; the two angles which lie below the transverse line will be respectively acute and obtuse, the former being on the lengthened side; and the iliac spine of that side will be seen to lie considerably lower than the other.

I would caution the surgeon to beware of drawing any conclusion from measuring the length of the limbs with a tape, for instance, from the spine of the ilium to the knee or malleolus, and also against comparing the relative position of the knees in sitting. No person with hip-disease, and, therefore, with fixity of the thigh, can bend that limb at right angles to the trunk; therefore none can sit straight and evenly, but must, of necessity, take some twisted posture, which will render any such comparison inaccurate and misleading.

Besides this posture-symptom, the second stage is accompanied by swelling. The post-trochanteric fossa has been described as rendered shallow by flaccidity of the gluteus. It now may be obliterated by tumefaction, which, however, is not very perceptible either to sight or to touch. Nevertheless, deep palpation, and careful comparison between the two sides, may reveal a fluid or semi-solid enlargement behind the neck of the bone. A fluid swelling from synovial distension will likewise show itself in front, a little below the fold of the groin, and opposite to its middle. There exist two sorts of swelling at this place. One is produced by effusion into the synovial membrane; it is characterized by round, soft enlargement, in which fluctuation can occasionally be detected; less often, yet in certain cases, the fluid-wave may be felt between this place and back of the trochanter. But the points most often and most useful to be remarked are, that the inguinal glands, still retaining their normal size, are pushed forward, and feel like small movable beads just beneath the skin. The femoral artery is also pressed towards the surface, so that its beat may be felt with unusual ease, and very superficial below the body of the pubis; at a point, therefore, where its pulsation is in the normal state of parts not very readily distinguished. The other form of inguinal swelling is entirely different. It is mainly produced by enlargement of the glands themselves, which may be felt swollen and big beneath

¹ It is well to point out that some persons have one limb (generally the right) longer than the other; but this does not produce fixity of the thigh, nor, in recumbency, obliquity of the pelvis. Coincidence of unilateral growth and of hip-disease might lead to a little embarrassment.

the skin, helping to conceal, or at least to render deeper and more distant, the beat of the artery. The former of these varieties of swelling, if it occur quite early in the case, indicates disease from synovitis; and it may arise at a later period during the progress of a rather acute osteal hip-disease. The latter form is throughout indicative of disease commencing in the upper part of the femur.

In certain cases, tumefaction also occurs about and below the great trochanter, on the outer side of the thigh. The swelling here is not very distinctly localized; it appears merely as increase of size, as an enlargement, not harder nor softer than the rest of the limb. It is not of good augury, indicating, I believe, extensive disease about the neck, near to the epiphyseal line. I have most frequently observed it in children of feeble constitution; such cases have, with very few exceptions, progressed badly.

Examination into the condition of the iliac fossa should never be neglected. In certain cases swelling in that place is a very early, in others a late symptom. The investigation, if the patient be fat, is not easy; and if he be a frightened child, and cry vociferously, it is, except with anæsthesia, impossible. It may be thus carried out: The patient, lying flat on the back, or a little turned to the sound side, has the knees drawn up and the shoulders supported on a pillow; then the surgeon, standing at the affected side, places his flat hand and fingers a little inside the iliac spines; by a rubbing and kneading movement towards the middle line, he presses the intestines over towards the other side; sinking this hand deeper and deeper in the direction of the sacrum, when he seems to have sufficiently intruded the hand he turns it outward, and may feel all the iliac fossa down to the brim of the pelvis; nor, indeed, should he be content, whenever the symptoms point to pelvic disease, with less than this. This examination should be made in the manner prescribed. If the fingers are merely placed on the flank, and at once pressed outward toward the iliac fossa, the surgeon will probably be baffled, may imagine himself to feel swelling where none exists, or may overlook real tumefaction. What he is to look for is an enlargement of the parts about the brim of the pelvis, obscuring the clearness of its line, and appearing to occupy the lower part of the iliac fossa, and thence to dip down and be prolonged into the true pelvic cavity.

During this stage the thigh wastes more markedly, the muscles, including the large gluteus, becoming soft and flabby. Starting pains increase, often very considerably, and in many cases occupy a larger space than they do at other joints, involving the whole length of the thigh, and passing into the knee; or they may be simultaneous at both hip and knee. When the stage of lengthening has persisted for a certain time, if these pains become more violent, and their recurrence more frequent, we may expect the advent of the third stage, which also, however, may supervene without any such prefatory warning.

Third Stage, or Stage of Shortening.—The change from the position which produces apparent lengthening to that which causes the contrary appearance, has, I believe, never been seen to occur; and yet this change is considerable; the thigh which was a day or two ago abducted, is found on a certain visit to be adducted, and the side of the pelvis which was depressed is now raised. How this is brought about in a limb which has seemed much fixed, and whether it occurs suddenly, or occupies a few hours, is at present unknown. The appearance is absolutely the opposite of that described in speaking of lengthening, but the buttock remains broad, and very often the great trochanter projects very considerably; otherwise, the description given at p. 501, may, by reversing the terms, suffice. When erect, the crista ilii of the dis-

eased side lies higher than the other; the rima natium slopes, and the lumbar spine curves, away from that side. The child stands with the toes on the ground, the buttock protruded on account of the flexion. In recumbency, the crista ilii of the diseased side lies highest, and the xiphoid cartilage, umbilicus, and pubic junction are all on the sound side of a string passing from the episternal notch to between the malleoli.

Fig. 616.



Third stage of hip-disease.

A point concerning the diagnosis of flexion in recumbency must be considered, for it often happens that the patient may be seen lying with the two thighs parallel, well down on the mattress, and apparently quite straight, and yet, nevertheless, there is considerable flexion. This fact may thus be verified. Study the position of the pelvis, and passing the hand beneath the lower part of the loins, observe whether it arches up, leaving a space

Fig. 617.



Flexion of thigh in hip-disease; pelvis in normal position.

Fig. 618.



Flexion in hip-disease. Obliquity of pelvis and arching of lumbar spine when limbs are parallel.

between itself and the bed. Then take the thigh and bend it up till it stands at an angle of 45° . Again examine the lumbar spine, which will now be found to lie flat. Replace the thigh on the bed, slowly and steadily, while the hand is still kept behind the loins. If there be flexion, as is very general in this stage, the pelvis will be found to become more vertical as the limb descends, and, since the shoulders are still on the pillow, the loins of necessity assume a very considerable incurvation.

The third stage of hip-disease, is more than any other the period of abscess,¹ although many cases may get well without suppuration. Those who manifest large diffuse swelling on the outer part of the thigh, or in the iliac fossa, do not often escape abscess. In the former case, the pus points generally half way down the thigh, either at the front or at the outer side; in the latter, either in the groin below Poupart's ligament, or at the back of the trochanter, finding its way out of the pelvis by following the track of the obturator internus muscle² through the sacro-sciatic foramen. In certain cases the abscesses are merely extra-articular; but more generally the joint is carious, and, the capsule having given way, there is also intra-articular abscess. A probe passed into the outer opening, however, near to the joint, will seldom

¹ Abscess, though it may occur, is unusual in the period of lengthening.

² This point of opening must not lead to an error of diagnosis; abscess from one form of sacro-iliac disease opens here, and I have seen the same in one case of spinal caries.

pass into the breach in the capsule, for, as already mentioned, the two apertures rarely correspond, and hence the instrument often does not afford any information.

In a certain number of cases, luxation undoubtedly occurs. I think, even, that some writers insist too strongly on its rarity. When it takes place, it brings with it a considerable abatement of the painful symptoms, which is sometimes complete and permanent, sometimes very transitory. Any sudden cessation of pain should lead to a careful examination. That luxation may occur gradually, has already been pointed out. I have more than once, during resection, found the head of the femur resting on the brim of the acetabulum, and scored by the evident impress of the acetabular margin. Clinically, too, I have learned to regard certain symptoms as indicative of this condition. When a child, suffering the ordinary pain of a chronic but pretty severe hip-disease, is suddenly affected by pain, evidently of a very severe character, holds the limb persistently in his hands, cries violently, and on the approach of any attendant screams with apprehension, or gives signs of severe pain when the bed is shaken; if we learn that since this access of pain first came on, the limb has been more drawn up; if, too, with these symptoms, are combined neither the local signs nor the temperature of suppuration, we are warranted in concluding that some disturbance of relationship between the head of the bone and the socket may have occurred—such disturbance is, in all probability, subluxation, which, if left to itself, will become complete. I was first led to this conclusion, in a case such as I have described, by observing, when, with the aid of anæsthesia, I endeavored to restore the limb to a proper posture, a certain unmistakable snap, such as only occurs on the replacement of dislocated joint-surfaces. Since then, other like cases have occurred to me—in all of them this snap has been felt, in some it has also been heard. Splints having been at once applied, the children awoke comparatively free from pain.

Occasionally it happens that diastasis takes place (page 495), and this also is accompanied by an apparent amelioration, which is persistent or not, according as the epiphyseal head left in the socket has contracted nutritive connections with the acetabulum, or, not having done so, simply remains as a sequestrum (see page 496). Not unfrequently, diagnosis or prognosis requires that a definite idea as to the state of the joint should be formulated. We want, namely, to discover if the abscess be intra-articular, if the bone be luxated, or if the epiphysis be separated. All these points may be investigated at one examination, assisted by anæsthesia.

In diastasis there is very considerable shortening,¹ and the limb is movable; sometimes very movable, and always more so than in hip-joint disease without such complication. Moreover, the shortness may be made to vary without changing the position of the pelvis. By pushing the knee upward toward the trunk, the limb may be reduced to its extreme of shortness; by dragging it down, it may be brought to its normal length, or even elongated. In carrying out these manœuvres, there occurs at a certain level, both in pushing and traction, a jerk or hitch, due, I suppose, to the truncated neck catching around the rim of the acetabulum. All this, to be of value, must take place without movement of the pelvis; indeed, it is better for the surgeon to let an assistant carry out these manœuvres while he himself steadies that part; he will then feel the trochanter gliding up and down upon the haunch.

The diagnosis of real luxation from mere change about the acetabulum and femoral neck, although not difficult, requires some nicety. It has been said that these changes produce a certain real shortening; but this never

¹ The amount of shortening increases with the duration of the diastasis.

amounts to so much as to be very plainly demonstrable. Dislocation always causes shortening that can be very plainly seen thus: While the patient is on his back, the surgeon marks with his eye a line at right angles to the mesial axis of the body, running from the sound anterior spine of the ilium across the abdomen; if he wish to be sure, he may even do this with a cord, and make a dot where it touches the pelvis on the opposite (the diseased) side. Now, let him place his fingers on the two anterior spines and note how high the one lies above the level of the other. He then compares the position of the knees or of the malleoli, and if he finds much more difference between these than between the two spines of the ilium, he may infer the great probability of dislocation. Of course, the words, "much more difference," are relative only; but I mean a difference evidently much more than can be accounted for by mere absorption of bone. It must also be remembered that, after luxation, the pelvis, unless the malady have been of long standing, becomes much less oblique. I have, indeed, occasionally seen it resume a perfectly normal position. Another test is Nélaton's line; it also is valuable; but, again, a certain allowance must be made for changes of shape in the bones themselves. The patient is placed on the sound side, and a string is laid athwart the pelvis from the anterior iliac spine to the tuberosity of the ischium; in a sound state of parts, this line always skirts the top of the great trochanter; but when the head and neck of the femur and the acetabulum are altered, that process rises a little, but only a little, above this line; when there is luxation it lies a good deal above it—from half an inch to an inch or more, according to the size of the patient. A dislocated bone always feels blunt and big, occupying a large space on the pelvis. The foot is, at first at least, always inverted.

The condition of parts in a non-dislocated limb is very different. There is an evident or sufficient correspondence between the amount of shortening observed at the knee or malleoli, and the elevation of the pelvis. The great trochanter does not lie much over Nélaton's line, but it projects considerably, having a rather sharp line above, and occupying but little space on the pelvis.¹

If the examination is only to be pushed thus far, there is no occasion for an anæsthetic, but if, the femoral head being in the acetabulum, we desire to investigate the condition of those parts—whether an abscess be intra-articular, and whether there be caries of the joint-surfaces—ether should be administered. When the patient is fully under its influence, the limb becomes to a certain extent movable, and it should be very gently impelled in all directions, while the hand is placed on the great trochanter. Sometimes certain positions cause an increased flow of pus from the sinuses. This does not always come from the capsule. When caries of the joint exists, crepitus may often be detected, or a peculiar, uneven and jolting method of motion, and frequently the axis of movement is found somewhat abnormal.

PROGNOSIS OF HIP-DISEASE.—The prognosis depends in part on the local condition, in part on the state of the general health. If there be joint-caries and abscesses, in and around, discharging large quantities of pus, the tendency to hectic and exhaustion is evident. The advent of lardaceous changes may also be expected. These conditions must be watched for by thermometric observation and the different sorts of examination detailed at p. 479. Increasing suppuration and the amount of these systemic changes may warn us

¹ The cause of the projection is twofold: (1) The thigh-bone, being higher, rests on a broader part of the pelvis; (2) the trochanter lies above the axis of the head and neck, and must therefore, in adduction, be thrown outward.

in certain cases that, unless an operation be undertaken, the patient can hardly escape with life.

But in many cases, after a certain amount of suppuration, perhaps after losing small fragments of bone, the patients begin to get better; the abscesses diminish, the discharge becomes less, the sinuses heal, and the patient gets well, but with a shortened and lame limb. Occasionally, this method of healing leaves behind an abscess which has not fully discharged itself, and the pus of which has become dry by absorption of its liquid part—the residual abscess of Paget; this may again suppurate, perhaps after many years,¹ and may cause the symptoms of active joint-disease to recur.

TREATMENT OF HIP-DISEASE.—At the very first symptom of *morbus coxæ*, the patient should be placed at complete rest, and, as a very general rule, extension also should be used, either by weights, or by my elastic-extension splint, interrupted by a bracket.² At the same time counter-irritants, such as blisters or other revulsives, may be employed. If the symptoms be somewhat severe, or if the constitutional dyscrasia be strongly marked, such antistrumous remedies as have been already mentioned are to be administered. But the patient is not to be left long in bed. When the symptoms of the first stage are slight, a fortnight—if rather more marked, a month—will suffice. Afterwards, one of the splints which permit exercise of other parts of the body, while enforcing complete quietude of the affected joint (described hereafter), should be employed. A large number of cases seen in the early part of the first stage will, if thus treated, get well without suppuration, and with no, or little, deformation or shortening.

But if the surgeon be called in at a later period, during the second or third stage, the good results of his treatment will be proportionately endangered. In the former event, the same management, but longer continued, will suffice, unless there be much distortion. In the latter, it is likely that the posture will require correction, for extreme flexion or adduction will not only thwart treatment, but will add to pain and subsequent distortion. If the malposture of the second or of the third stage be strongly marked, the most prudent course, especially if there be much pain, is to let an anæsthetic be administered, gently bring the limb into a proper position, and at once apply the apparatus for extension. Weight-extension, if used alone, has the defect that, although the limb itself may be motionless, the trunk, together with the pelvis, may be flexed to one side or the other, so that the same peccant angle may be produced at the hip—abduction or adduction being, under such circumstances, caused not by movement of the limb on the trunk, but by motion of the pelvis on the thigh. To obviate this, there should be laid on the sheet which covers the patient three sufficiently heavy sand-bags;³ one, on the outer side of the affected limb, extends from axilla to foot; one, on the inner side, from the perineum to the same point; while on the unaffected side of the body, another bag is to reach from the axilla to the hip, thus leaving the sound lower limb and both arms at liberty, but preventing improper movement both of the trunk and of the diseased limb. For unquiet, restless children, it is sometimes better to secure the sound limb and that side of the trunk to a long Desault's splint, as in simple fracture of the thigh, without, however, making extension from the foot, which on that limb is unnecessary; but weight-extension must be of course adapted to the other leg. The extending

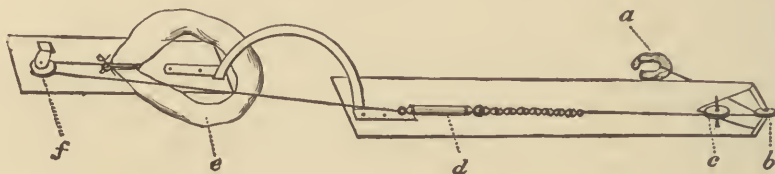
¹ I have several times been consulted in the case of a gentleman in whom such an abscess recurred nineteen years after its apparent cure.

² See Fig. 619, p. 508.

³ The sand must be thoroughly dried and warmed.

weight should be from one to three pounds, according to the size of the child. It is well, lest the power slowly drag the patient downward, to raise the foot of the bed by placing blocks about four inches high beneath the supports of that end, establishing a general slope downward to the head, and causing the child's body-weight to act as a counter-extending force. But, as a rule, I prefer to achieve both objects—immobilization and extension—by the use of my extension-splint, with a bracket of steel or brass interrupting the support-

Fig. 619.



Bracketed extension-splint for hip-disease.

ing parts, and so shaped that the upper or body portion shall be nearer the patient than the limb portion. The former must be long enough to reach from axilla to ilium; the latter from a little below the trochanter to three inches below the foot. The mode of procuring extension has already been described (p. 429). The value of this appliance is, that it secures immobility. It may also be used to rectify malposition, for which purpose it is more effectual than the weight.

If, when the surgeon first sees the case, there be less malposture, and if the pain be comparatively slight, sudden rectification will not be necessary; but the patient being placed in bed, elastic extension may be at once applied. It ought to be made in a plane slightly lower than that of the axis of the limb. In some cases the patient may be placed on a bed with a hinged base, so that the part below the middle can be placed at an angle with the rest, the part on which the limbs rest, together with the weight, being lowered a very little day by day. Or the same thing may, with less expense but with more difficulty, be managed with a board beneath the mattress, that can gradually be lowered. With my extension splint it is only necessary to bandage, or, rather, to strap on with a broad belt, the upper division of the splint, and to apply the extension. The elastic force soon tires out the contracted¹ muscles, and the deformity yields more or less rapidly, according to the tension of the India-rubber spring. An attendant must, from time to time, hook this up higher on the chain, to equalize and maintain the force.

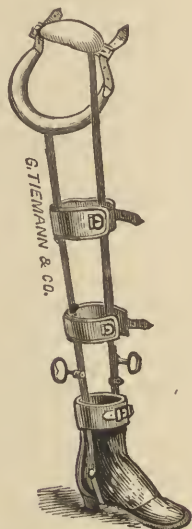
By one or other of these means the limb is to be placed in a good posture, and, for a period varying from ten days to six weeks, or even more in very severe cases, the patient is to be kept in bed, and, as far as the hip-joint is concerned, rigidly still.² At the end of this period the symptoms, though still persisting, will have become more quiescent, and now means should be adopted which will allow the patient to take exercise, generally with the aid of crutches. American surgeons may rightly claim priority in the invention of splints designed to maintain extension while the patient moves and walks;

¹ Contracture in the sense already explained has not yet commenced.

² I give here what I find, from very considerable experience, to be the best treatment in by far the greater number of cases, though it should be noted that some surgeons apply apparatus, to be now described, and let the patient walk at once. That method succeeds in a certain percentage only of cases.

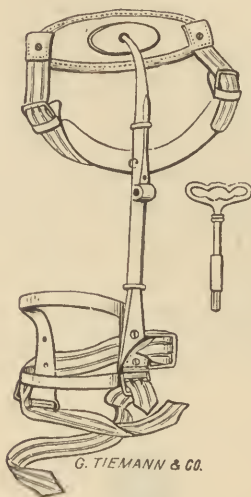
they are constructed with the idea of supporting the weight of the body on the ramus and tuberosity of the ischium, while extension is made, by adhe-

Fig. 620.



Prof. Sayre's long splint for hip-disease.

Fig. 621.

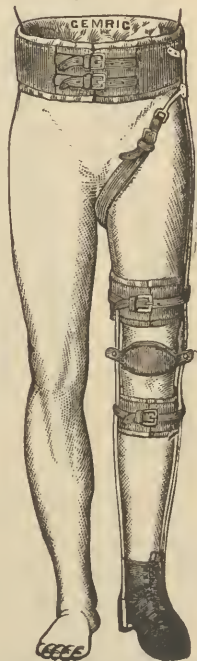


Prof. Sayre's short splint for hip-disease.

sive plaster or otherwise, upon the limb. Dr. H. G. Davis's splint had certain mechanical defects which have been to a great extent eliminated by Dr. Sayre, who has frequently described his long and short splints. These are used as follows: To the ends of long strips of plaster (in the case of the short splint cut fan-shaped) applied to the thigh, firm webbing is sewn, which, passing under rollers at the lower end of the splint, is secured to buckles at its outside. The perineal strap is fastened firmly, but not too tightly, and then by means of a rack and key the splint is lengthened until it produces a sufficient amount of extension, being slightly longer than the part of the limb on which it fits. The object is to prevent weight falling on the joint, even though the patient stand on his foot, but to allow, and indeed to provide for motion, by placing a ball-and-socket joint at a point opposite the hip. Both these splints have been frequently used by myself as by other surgeons; but they have not found much favor in England, nor generally in Europe. It appears to me impossible to secure their object, namely, extension on the limb while the patient stands on his foot; the failure being due partly to slipping of the adhesive plaster on the skin, partly to the skin itself and the soft parts immediately beneath it moving over the deeper structures and the bone. After a very short time, a large portion of the weight falling, not on the perineal band, but on the hip-joint.

Some modifications of Davis's original splint, namely, Pancoast's and Taylor's, do not attempt to make

Fig. 622.



Prof. Pancoast's splint for hip-disease.

extension by applying plaster to the skin; but the instrument, extending from above the great trochanter, is let into the heel of a well-fitting boot, and, being provided with a slide and ratchet, can be lengthened until sufficient pressure on the perineal strap shows that weight thrown on the foot will, in a great measure, be transmitted to that strap, and not to the joint. Additional security is given by providing the upper part of the appliance with a pelvic and two perineal bands. Dr. Andrews, of Chicago, I believe, first hit on the idea of providing the top of these instruments with a sort of crutch-handle, well padded, and fitting the rami of the ischium and pubis. The upright lies only on the inner side of the limb, and is hitched into the heel of the shoe.

These splints, it is to be observed, all permit of very considerable mobility of the hip-joint; and, indeed, Dr. Jos. C. Hutchison goes further and applies no retentive apparatus whatever to the diseased limb, but, merely supplying the patient with a high-soled shoe for the foot of the sound side, and a pair of crutches, allows him to go about at his own will and pleasure, not even taking the precaution to confine the limb at night. Dr. Hutchison points out, what, indeed, is quite true, that "immobility is secured by reflex contraction of the periarticular muscles, aided by intracapsular effusion, and the

voluntary effort to keep the joint at rest on account of the pain which motion produces;" but I would remark, that any extraneous aids for fixing the joint are valuable, according to their power of superseding and preventing those reflex and voluntary contractions which so powerfully press together the articular facets, and thereby certainly add to the pain of joint-disease, as well as aggravate the disease itself.¹

Mr. Thomas, of Liverpool, starting with a different view, desires to secure complete immobility of the hip-joint, by means of a posterior splint with a longer bearing, and entirely devoid of any hinge-joint. The appliance, made of soft iron, consists of an upright, long enough to reach from the level of the angle of the scapula to below the middle of the calf; this must be rather over an inch broad, and thick enough to resist mere muscular force, but not too thick to be bent with wrenches. It must be thus bent or moulded, so as to fit, not very closely, the incurvation of the loins, but much more nearly the nates and its fold; below that last point it may be straight. This portion of the apparatus bears three cross-pieces of weaker and narrower iron, the first of which encircles the thorax, and is provided with a strap and buckle to keep it somewhat loosely applied, while the second encircles the



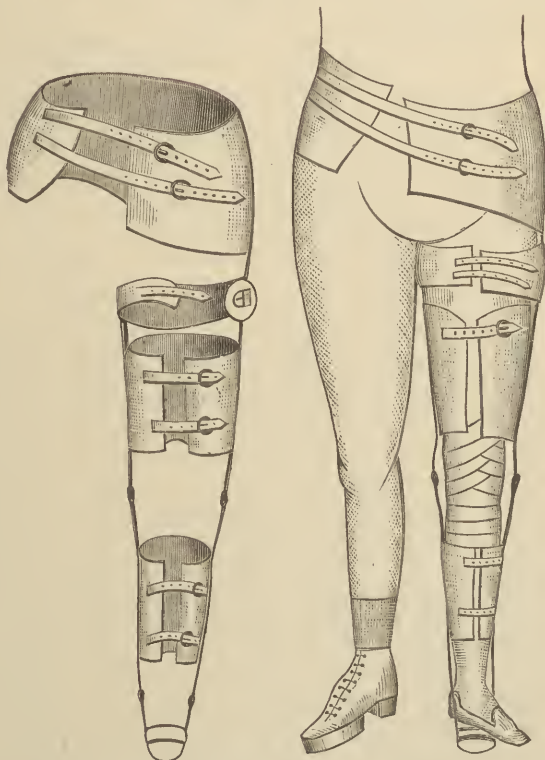
Thomas's splint for hip-disease.

thigh a little above the knee, and the third embraces the leg. These must both be so long that their ends overlap each other in front, to permit which they are placed on the upright with a very slight obliquity. The whole is

¹ I shall have to show immediately that this method, like the use of Thomas's splint, gives no security, except the will of the patient, against placing weight very frequently on the diseased limb.

covered with leather, and bands of webbing passed over the shoulders prevent its slipping down; the splint must be bandaged both to the trunk and to the limb. A high-soled shoe is to be placed on the sound limb, and a pair of crutches provided, when the child is allowed to walk about. This splint has been much employed in England, and in some other parts of Europe. I have had many successful results from its use, but chiefly in early cases, or with very docile patients. It has certain marked defects. Hardly any patients can lie down in it, unless provided with a soft feather bed; defecation is difficult, and generally can only be managed with a flat bed-pan in the recumbent posture. It does not so entirely prevent motion as Mr. Thomas imagines; rotation especially is quite possible within the splint. Many patients, thoughtless or indocile, constantly manage, in spite of considerable watching, to bear a great deal of weight on the diseased limb while partially sitting on the sound buttock, or by kneeling with the well limb on a chair, and letting the foot of the unsound one rest on the floor. High-spirited lads, full of life and fun, are constantly, by some means or other, getting their weight on the diseased limb—not, of course, during the acute and painful stage, but afterwards—and thereby prolonging the disease.

Fig. 624.



Dumbrowski's splint as modified for use in hip-disease.

Another splint, of which, from the little experience I have as yet had with it, I think highly, combines the principle of immobility with that of taking the weight off the limb. It is similar to that described at page 431, with the addition of a moulded-felt portion for the ilium, to which the metal rod extends. There is no hinge opposite either hip or ankle; but there is one at

the knee. In those that I have had made, my directions have been to place an additional thickness of metal over the splint, from the middle of the ilium to the middle of the thigh, so as the more securely to guard against adduction. With this instrument, immobility of the hip is to a great measure, if not entirely, secured. The foot never comes to the ground, and therefore no body-weight can be transmitted from it to the hip; care, however, must be used that during its application the limb is drawn well down, or weight is likely to be transmitted upward from the splints around the thigh and leg. A great advantage is, that mobility of the knee is not interfered with. After a very little practice the patient can walk quite well with this splint, without crutches.

When the foregoing few pages are considered, it will be impossible to deny that the surgeon has a very wide choice of appliances for the treatment of hip-disease; and, indeed, if we could accept, without any grains of salt, the dicta of each inventor, any and all cases of hip-disease would be easily curable. But a saying of my revered teacher, Mr. J. H. Green, was marked by his well-known wisdom. "Whenever many instruments are invented to fulfil a given purpose, we may be certain that not one of them is capable, under all circumstances, of satisfactorily doing so." And thus, although by these various means—even by Dr. Hutchison's absence of appliance—success will, in a certain number of instances, follow; yet in certain cases, in spite of the most careful and skilful treatment, caries and suppuration will set in and continue. Such cases occur in persons in whom the strumous, serofulous, or tuberculous taint is strongly developed, and in whom inflammation of bone (the part primarily attacked) runs on to exuberant granulation, perhaps with caseous or fatty degeneration, followed by softening and suppuration. That the various extension splints of Davis, Sayre, Taylor, Andrews, and others, have been more successful in America than in Europe, is, because in the younger country struma is less widely spread, and less deeply scored, and patients have greater facilities for obtaining fresh, good air than on this side of the Atlantic. Nevertheless, I must repeat that the right idea, and that most likely to produce good results, is the American, viz., to get the patient moving about as soon as possible. In the earliest stages of the more chronic form of the disease, it is evident that Dr. Hutchison's plan may in some cases suffice. Sayre's or Taylor's splints are admirable in cases which are rather more acute; but in the severer forms even these do not answer, for excision is an operation which is still practised in America. In such cases we must not only secure the joint against pressure, but also, by some means other than muscular contraction, against motion. Thomas's and Dumbrowski's splints seem to me the best which have been devised up to the present time; the latter is that which I choose in severe cases. The defects of both have been mentioned; those of the latter are apparently inseparable from any immobilizing appliance.

When suppuration supervenes, the surgeon must be guided in his treatment by its quietude or vehemence. If the formation of pus be accompanied neither by pyrexia nor by marked increase of pain, the same treatment, that is, rest to the joint and movement in other parts of the body, should be maintained; and the surgeon should wait until the abscess is pretty near the surface before interfering; when near enough, he should open it pretty freely, wash or syringe out the wound, and pass just within its lips a drainage tube, still persevering in the same treatment, and being very careful to maintain the limb in a straight line with the body, and as little adducted as possible. Many children go through a lengthened period of quiet suppuration, and ultimately get well, with a limb, it must be confessed, a good deal shortened—partly by position, partly by alterations, already described, about the cervix and acetabulum, partly by cessation of growth. The joint too is generally stiff.

But if suppuration be more acute, and be attended by pyrexia, and by very considerable increase of pain, it will be necessary, for some time at least, to enforce recumbency, and to keep up extension with immobility, by means of one of the appliances already described; it may be desirable to carefully examine and correct the malposture under an anæsthetic,¹ and, if so, this must be done with the greatest gentleness. At the same time, abscesses should be sought for, and, if of sufficient size and tenseness to be a probable source of pain, should be opened with proper antiseptic (not necessarily Listerian) precautions, and then syringed and drained. In a few days or weeks, when fever has subsided, the patient may again be provided with a suitable splint, and allowed to go about.

Intrapelvic abscess, especially if large, is a very serious condition in hip-disease, generally indicating necrosis, present or soon to follow, of the acetabular floor. Such disease, however we may treat it, by rest, tonics, and exercise, usually demands excision, and an opening, either by removal of sequestra or by trephining, through the acetabulum. Sometimes the abscess discharges itself either below Poupart's ligament or through the ischiatic notch, and débris of bone may come away, and, after years of suppuration, the patient may recover. But, also, I have known such an abscess to open into the rectum or bladder. Every case of large intrapelvic abscess is attended with danger, either from bursting into one of the cavities above named, or from continuing for a lengthened period, profuse suppuration ultimately wearing out the patient.

Suppuration in the hip-joint is a disease during which the surgeon must in great measure wait upon events, taking care to maintain the limb in good position, to keep the discharges free from putrefaction, to uphold the patient's health and strength, and, if necessary, to seize the proper moment for excision, which, however, if patience and care be exercised, is not often needed.²

DISEASE OF THE SACRO-ILIAC JOINT.

The synchondrosis between the sacrum and ilium differs from the joints with which we have hitherto had to do, inasmuch as there is here no true diarthrosis, but a half-joint—an amphi-arthritis. The two bones are chiefly bound together by coarse-fibred ligament, but at the auricular part a layer of cartilage covers each bone. This is considerably thicker on the sacrum than on the ilium. Between the two, lies, in some persons, a yellow tissue, very like the central parts of the intervertebral substance. In other subjects a bursa occupies that situation.³ Hence, as the constitution of the joint is simpler than that of others, so also are its diseases. They are all due to osseous inflammation and its effects—caries, caries necrotica, and, when occasionally a larger sequestrum entitles the disease to be so named, necrosis. The locality, however, where these processes originate causes a very considerable difference, from what they present elsewhere, in their symptoms, prognosis, and treatment; and therefore cases of sacro-iliac disease, though simple in pathology, are, clinically, often extremely obscure.

In many cases the inflammation and its resultant caries commence at the front of the sacrum, being exactly similar to spinal caries; only, as the conjoined parts of that compound bone are not movable on each other, no angular curvature takes place. The disease may spread upward and downward, as well

¹ The possibility of subluxation (see p. 505) must not be overlooked.

² The question of hip-excision, early or late, is treated of in another part of this volume.

³ For anatomical details, the reader is referred to an excellent monograph by Luschka. *Die Halbgelenke des menschlichen Körpers.*

as backward towards the sacral canal, and may commit great ravages before invading the sacro-iliac joint; or it may extend laterally, and very rapidly involve the synchondrosis. Another form of the disease attacks *ab initio* the lateral surface of the sacrum, or more rarely the auricular face of the ilium.

After a certain time suppuration is set up, and the resultant fluid finds its way to the surface in one of four directions. It may, if the disease be low down on the sacrum, appear about the anus, simulating an ordinary ischio-rectal abscess. If higher on the front of that bone, it passes along the pyri-formis muscle, and points behind the great trochanter. If at the posterior part of the synchondrosis, it shows itself over the sacrum. While in some cases it appears under Poupart's ligament, I am unable to specify the exact place of caries which produces pointing in that locality. Not unfrequently the pus has not sufficient exit at the spot first selected, and then points also in one of the other places. The abscess being opened, a probe may be passed along its cavity, and may, in certain cases, impinge upon dead or diseased bone. This happens more frequently when the opening is either behind the sacrum or at the groin. It is generally impossible to touch the site of disease when the pus has pointed either behind the trochanter or near the anus; but I have twice succeeded in doing so from the former place, once from the latter.

The prognosis of all these cases depends on the locality of the disease, and on the mode of termination taken by the inflammation. The malady which is above described as spinal caries affecting the sacrum, terminates, as a rule, sooner or later in death, which is generally lingering, and ultimately due either to exhaustion, to lardaceous disease of the viscera, or to pulmonary complications. The disease affecting primarily the lateral surface of the sacrum, or the ilium, is of worse prognosis the further forward the disease is situated. In quite young people the inflammation may end in necrosis, which is more hopeful than caries.

SYMPTOMS.—The first signs of sacro-iliac disease differ considerably, according to the particular part involved. In some cases the earliest symptom is pain along the sciatic nerve; and this, when the disease affects the front of the sacrum, and before it encroaches on the joint, may be for a long time the only complaint; nor, indeed, at this stage, is any clear diagnosis possible. Suspicion as to the condition may be aroused by pressing from the front of the abdomen backward. This in sciatica does not, but in sacral disease occasionally does, cause pain. Succussion and percussion at the back of the sacrum are frequently painful in commencing caries. Examination by the rectum affords, unless the disease be too high, useful information, pressure backwards causing considerable pain. If the disease do not spread laterally, but simply erode deeply towards the sacral canal, the symptoms are very obscure, and the diagnosis exceedingly difficult.

When the lateral surface of either ilium or sacrum is affected, a peculiar instability, lameness, and weakness of the lower limb is produced; the pelvis, too, becomes oblique, and the leg of that side is apparently lengthened, rarely shortened.¹ In this state there is some resemblance to hip-disease; but the diagnosis is not difficult, because *there is no fixity of the thigh*. It is true that movements may be painful, but if an assistant fix the pelvis without too much pressure, the pain ceases, or is mitigated. If the patient be directed to raise himself on the toes, and then suddenly to come down with a sharp jog

¹ I saw in one case, in a lad of 14, a shortened limb with a large abscess behind the trochanter. The shortening amounted to nearly $1\frac{1}{2}$ inches, and on this account the possibility of the disease being sacro-iliac was doubted. The boy was very ill when he came into the hospital, and died in about three weeks. On post-mortem examination, extensive disease on the front part of the sacrum was found, involving deeply the right synchondrosis.

on the heels, considerable pain will be felt. Also—and this is a very important symptom—if the surgeon places a hand on each ilium of the recumbent patient, and then by a sudden movement of both towards the middle line compresses the two bones as though he would drive them together, and if, when an assistant steadies one side by firmly grasping the ilium and its anterior spine, the surgeon, holding the other bone in a like manner, jerks it outward as though he would sunder the two ilia, pain nearly always follows one or the other, sometimes both movements.

When the disease attacks the posterior part of the juxtaposed surfaces, there are pain and swelling, and subsequently abscess inside the posterior iliac spines.

With attention to these details, the diagnosis of the disease, when either primarily or secondarily it invades the joint, is always feasible. But to detect a deep caries of the sacrum, especially if it lie beyond the reach of a finger passed into the rectum, is occasionally impossible. In 1879, a man aged 24 was under my care with obscure symptoms and great weakness; he was evidently very ill. After seven weeks, an abscess appeared under Poupart's ligament, and twelve days afterwards he complained of weakness in the right leg, which he could not lift from the bed; the attempt to do so gave him great pain; the limb was lengthened, but the hip-joint was perfectly free. I now diagnosed disease of the sacrum, spreading towards the right ilium. Exactly a week after this he had four fits of convulsions, became comatose, and died. At the post-mortem examination, a deep, carious ulcer was found in the first and second portions of the sacrum, and involving also the lowest part of the last lumbar vertebra. The spinal canal was perforated, evidently recently, and was full of pus.

TREATMENT.—The treatment of sacro-iliac disease depends upon its locality, as above described. In cases of extensive caries of the front of the sacrum, we can do but little further than trust to rest and tonics. But when the lateral surface only of the sacrum or ilium is involved, we may be more hopeful of doing good by treatment. Rest should be enforced, at first on the back, and, if the disease be not severe, a pillow under both thighs and knees is advantageous, as patients move much less in such a position than when allowed to lie straight. If the symptoms be rather acute, I have found advantage in placing a Desault's splint on the limb of the sound side and making weight-extension on the other. If the patient be restless, these appliances may be supplemented by laying over the patient a sheet weighted with sufficiently long sand bags. If there be much pain, great relief is obtained, and I think the disease may sometimes be checked, by drawing a line with the actual cautery along the joint, or by making by the same means an eschar just inside the posterior-superior iliac spine. Of course, when the patient lies on his back, this cannot be done; a prone couch must first be procured. Even then, however, such treatment has its disadvantages, since the cicatrix, if the disease be protracted, may give way when it becomes necessary that the patient should resume a supine position. For the same reason, blisters can only be used if a prone couch be available.

If an abscess form over or close to the sacrum, it should be opened sufficiently early, and the surgeon should take this opportunity of examining the condition with his finger and with a probe. In some cases a very superficial, in others a deeper caries will be found; in some an opening, a sort of osseous sinus or cloaca, will be found passing through the joint to the pelvis, or again in others the probe impinges on a sequestrum. In all these events, surgery will be of benefit. The removal of a sequestrum by enlarging the opening has, twice in my hands, proved curative; and when caries, lying at the back

of the joint, is accessible without any great difficulty, a gouge and the osteotrite will remove the disease, and may entirely cure it, though probably slowly.

But when a passage leads right through the sacro-iliac joint into the pelvis, very careful examination and consideration of the case are required. The passage may either affect the joint only, or it may be a sinus leading to very extensive disease in front of the sacrum. All this must be examined into by the methods above described. If no clear evidence of anterior sacral disease can be found, the proper course is to enlarge this passage, clear away any softened bone with a small trephine or with a gouge, and pass a drainage-tube into the pelvis. Such treatment will often be useful,¹ but the case will progress very slowly.

If the surgeon have reason to believe that the front of the sacrum is diseased, his course will depend upon the more or less debilitated state of the patient. If he be emaciated, and much worn by pain or by suppuration, there is probably nothing to be done save by rest and medicine to alleviate his sufferings. But if he be still fairly strong and robust, I would strongly advise perforation along the sinus-track, and drainage. The rapidity of the disease is certainly lessened by keeping the pelvis and the carious surface as free from pus as possible.

ANCHYLOSIS.

The term *Anchylosis*, or *Ankylosis*, which is derived from a Greek word (*ἀγκυλώω*, to bend sharply), did not originally signify, as it now does, fixity or stiffness, but a bend or angle. This singular change in meaning necessitates the use of awkward and pleonastic language; we often have to speak of a straight or of an angular anchylosis.

Anchylosis has been frequently mentioned in the foregoing pages as one of the modes in which affections of joints may terminate; it is therefore not a disease, but the more or less inconvenient result of a past malady. It is due to the adherence together, by bands of new and abnormal material, of two joint-bones. The new material is formed from inflammatory products, nearly always from granulations which have become tissue that may have remained fibrous, or may have developed into bone. In the former case, the anchylosis is called false, in the latter, true anchylosis.² The new material is an inflammatory product, whose origin has to a certain degree been traced. We will here take up the narrative at that point when either a synovial or osteal inflammation has destroyed the cartilages and the articular lamella, filling the joint-cavity with granulations springing from the synovial membrane and from the bony cancelli, or rather from the membrane lining the cancelli. When these granulations, more especially those from the two opposite bones, have coalesced, the next step is the conversion of these embryonic formations into fibre-cells, and then into a coarse, cicatricial fibrous tissue, which, of course, involves also the granulating synovial and perisynovial structures. Thus, the two bones become joined together by a strong bond which has taken the place of the joint-cavity. If a section be made of an articulation advancing towards this condition, it will be noticeable that fibrification of granulations proceeds chiefly

¹ Three years ago I performed this operation for a young woman, and in three months she was able to walk short distances without pain, wearing a broad belt. The discharge from the wound became quite trifling, but this remained open for nineteen and a half months, and then healed; she is now perfectly sound.

² Other causes of joint stiffness, viz., thickening and shortening of synovial and perisynovial tissues, and muscular contraction, will be discussed hereafter.

from the bone; from every cancellar wall a fasciculus of fibres appears to spring, and to advance into the midst of the granulations, the separate bundles diverging a little. In the interspaces formed by this divergence, may still be seen collections of granulation-cells—round in certain parts; spindle-shaped, or already becoming distinct fibre-cells, in others. Wherever the tissue is more advanced, no such structures remain; the whole mass has become fibrous. In the mean time, the granulating synovial tissues likewise cicatrize in the same way; yet it does not appear that fibrillization spreads thence much towards the central parts of the new tissue, but rather outwards, into as much of the periarticular tissue as was previously inflamed. Now, in all cases, as in every cicatrix, this new tissue has a great tendency to contract; hence, unless prevented, the bones will become, for a certain time after fibrification is completed, more tightly bound together, and the circumference of the part, no longer deserving the name of a joint, will diminish. Any sinus-mouths that remain will from the same cause be drawn inward, and become depressed cicatrices. But a further step in organization is often taken; the fibres become bony, ossification creeping along them from the cancellar plates towards the centre, forming, since the fibres are interlaced, a bony network, which afterwards is fashioned into properly-formed cancelli, while the outer layer becomes a cortex of solid osseous tissue; so that ultimately a section through both bones will not exhibit any line of junction. Before me now are two such sections, one of the hip and one of the elbow; in neither is it possible to trace where the one bone begins and the other leaves off, neither can any intermediate uniting material be found. The process, as thus described, is a slow one, such as may follow chronic disease; and, indeed, when ankylosis results from acute malady, the production of its false form is generally, of the true form is always, slow. But there are certain diseases, as for instance dry synovitis and some forms of absorption-disease, which seem to result in a very rapid, true ankylosis. The process whereby such a result can be so quickly achieved is very difficult to understand; it is probably, however, much the same as, only much more rapid than, that above described. We know that there is such a thing as an acute ulcer of cartilage, with clean-cut edges; there is therefore no difficulty in that direction, but the rapidity of bone-formation is not easily comprehensible.¹

Every stiffened joint, however, does not owe its immobility to ankylosis; for, as we have seen, synovial disease may expend its chief activity on the surroundings of the joint; or, again, a synovitis may have been cured at a stage when only a part, at the periphery of the articular cartilages, has been destroyed, the cavity having been encroached upon but not filled up by inflammatory products. In the former case, the loss of mobility is due to periarticular impediments; in the latter, to what are often termed bands of adhesion. These bands run from bone to bone, attached to points whence the cartilages have disappeared, and projecting from the thickened synovial membrane into the cavity, as the columnæ carneæ of the heart project from the wall into the lumen of the ventricle. Their ill effect on the function of the joint depends upon their brevity and upon their position. As a matter of fact, these two causes of joint stiffness are usually combined; bands of adhesion probably never occur without periarticular impediments, though the latter may occur alone.

To complete this view of joint-stiffness, we must add yet another cause, namely, muscular contracture, the pathology of which has already been examined. With this is frequently combined fascial shortening, sometimes

¹ Patients with the diseases in question suffer great pain, or are very ill; so that the affected joint is likely to escape examination, and there may in these cases be some error of observation.

merely the result of long-continued position, but sometimes also due to inflammatory changes propagated from the perisynovial structures.

The *diagnosis* between true ankylosis and all other forms of joint-stiffness depends upon a perception of entire immobility, which is much more easily made out when the surgeon has to do with a joint that lies between two bones of considerable length, such, for instance, as the knee, than when one of the bones is short, well covered, and difficult to fix, or has other joints in close proximity to that which is being examined, the problem then being difficult, and sometimes impossible of solution. Some aid may be obtained by watching the muscles which move the joint; in true ankylosis these remain during examination perfectly passive, but in the false form of union the flexors twitch on any attempt to straighten the extensors, or any effort to bend the limb. The twitch, if the bonds of a fibrous ankylosis be very short, is often slight enough to be doubtful. In true ankylosis, the muscles above the joint are more completely wasted than those below. If points of bone close to the joint, both above and below, be sufficiently superficial, the surgeon may listen through a stethoscope placed on the one, while the other is sharply struck, an ivory pleximeter being interposed. The sound transmitted from one bone to the other will be much clearer and brighter if the ankylosis be true, than if it be false.

When some mobility, muscular twitching, or other symptom, indicates that no true ankylosis exists, there still remains to be discovered the cause of what immobility there may be. A false ankylosis, if the bones be very closely bound together, yields but very little, and even that little with a reluctance which it requires some force to overcome; but when the uniting fibres are longer, and the bones therefore further apart, the joint may permit movement through a certain space. The movement, however, is not entirely free, still requiring some force, and the more according as the limb is brought further from its accustomed position, until at length it will go no further. The movement is constrained, and the check gradual.

When the so-called bands of adhesion produce stiffness, lameness of various kinds and degrees may be produced. All movements, for instance, may be free save in one direction; or they may be all free to a certain, perhaps to a very small, degree, but within that degree perfectly free—restricted but not restrained. The check is very sudden, and, as a rule, unyielding. The same thing may be produced by ligamentous shortening, but when the limb is moved as far as it will go in the restricted direction, and a little further propulsion is added, bands of adhesion, being stretched, give a more or less sharp, sometimes a sickening pain; while shortened ligaments are always painless, or nearly so, when moderately stretched. Muscular contracture rarely stands alone as a cause of joint-stiffness, but when it so far predominates as to be considered in the question of diagnosis, there will rarely be any difficulty in distinguishing it from other conditions, even during consciousness. The limb moves quite freely till checked, and is stopped by an elastic and yielding hindrance; pushed still a little further, and suddenly released, it flies back as though by a spring. During these manœuvres the movements of muscles and tendons can be very plainly felt.

But, unless the case be almost self-evident, it is better to put the patient under the influence of ether, after he has been examined during consciousness. This rule especially applies to such joints as present difficulties in the matter of diagnosis, and particularly to the shoulder, hip, and ankle. The advantage gained by a resort to anaesthesia is absence of muscular resistance, permitting the recognition of slight flexibility or rotation, which could not otherwise be detected.

TREATMENT OF ANCHYLOSIS.—In order to advise whether joint-stiffness should be subjected to any treatment, many points have to be considered: (1) The inconvenience which the immobility produces. (2) The amount of advantage which any interference is likely to confer. (3) The severity of any operation necessary to produce adequate results.

The decision of the first question must depend in part upon the importance, in part upon the position of the joint; for instance, stiffness of the hip is a matter of more importance than that of the knee, and more important than that of the ankle, while stiffness is of less importance at the shoulder than at the elbow, because mobility of the scapula so greatly compensates for fixity at the scapulo-humeral joint; but the locality of the stiff joint is of less moment than the posture in which it has been ankylosed.¹ Thus, a shoulder fixed very close to the side, a straight elbow, a flexed wrist, a flexed hip or knee, are all very inconvenient; while the ankle fixed in any posture but such as allows the foot to lie at right angles to the leg is, according to the amount of its deviation, very awkward; therefore, to overcome joint-stiffness in any of these inconvenient postures, an operation may be advised of much greater severity than would be desirable for any of the joints in a less inconvenient position. Especially, too, must we take into consideration the worldly position and surroundings of the patient, whose usual occupations, whether for pleasure or livelihood, may be entirely prevented by fixity of a joint in some awkward and embarrassing posture.

The problems with which the surgeon has to deal are these. In case of fixity in an inconvenient posture, can a better position be secured? And whatever be the posture of fixity, can we give to the joint motion through certain limits without at the same time producing abnormal mobility? The answers to these queries depend, in part, on the joint affected, in part on the cause of stiffness. The relative ease with which these causes are overcome lie in this order: Most easy, other things being equal, is muscular shortening;² next, perisynovial thickening and bands of adhesion; third, false ankylosis with long fibrous bonds; fourth, false ankylosis with short bonds; fifth, true ankylosis; and in the same order stands the possibility or probability of securing some mobility. Those joints in which the socket of the one bone does not much embrace or surround the head or condyle of the other, are more readily changed in position than others, and mobility is more easily conferred upon them; but such joints, the area of contact being small in proportion to the size of the articulating surface, are apt to be thrown by ill-directed force into subluxation, or to receive mobility in abnormal directions.

We will, for the present, leave the methods of dealing with true ankylosis, and study the treatment in different articulations of other forms of joint-stiffness; we shall then be in a better position to consider the sort of cases which may be subjected to those methods, and the cases which should be let alone.

The general method of treatment, and the precautions to be observed, may be given thus: In mere contracture, section of tendons, muscles, or fasciæ, will be sufficient to allow replacement and mobility; but since some of the other causes of fixity are usually also present, it will be better to be always prepared for further interference. The patient should be completely under the influence of ether. If scars are situated on the side towards which the deformity inclines, they will have to be separated with a tenotome from underlying parts; if they are flat, and have a pretty even surface, this can be

¹ In the preceding pages I have very frequently insisted on treating joint-diseases in a good position, but the subject may here again be reverted to as being so extremely important, since the best posture for treating articular inflammation is also the most suitable should ankylosis occur.

² Save in certain cases when the shortening muscle cannot safely be reached with the knife.

done at the time when the other steps are taken. If they are depressed and funnel-shaped, they can rarely be divided without cutting off their neck, and leaving a gap in the midst; if this is on the side of deflection, the hole may, in stretching, tear. Hence it is better to divide such depressed cicatrices some days before the chief operation, and, by moving them frequently over subjacent parts, prevent them from again becoming so closely attached. This little procedure is generally so painless that it may be done without using an anæsthetic.

The change of position, or restoration of movement, is to be effected, under deep anæsthesia, by the judicious, yet resolute application of manual force. The object of the procedure is to break through the thickened tissue of perisynovial impediments, or of bands of adhesion, and also to rupture the shorter and thicker, impeding attachments of false ankylosis. If these parts be merely stretched, inflammation, or sometimes considerable pain without demonstrable inflammation, follows, and the operation will have been useless, or even injurious; but rent cicatricial bands very rarely inflame, especially if the rupture be complete. The surgeon's object should be effected by a series of jerks, carried out thus; the limb should always first be impelled in a direction opposite to that in which we wish to move the joint; for example, if we desire to flex a limb fixed in too straight a position, we first extend it still further, rupturing probably a few bands, and then flex it till a sufficiently decided resistance is encountered; next let the part recede a little towards extension, in order to gain a little impetus, and then by a rapid, but not violent, motion towards flexion, rupture the first and probably chief impediment. We press the limb again towards flexion until other obstacles occur, and repeat these manœuvres until all are overcome, or at least until all has been done that is considered safe and desirable. If any point has been, during examination, found to be painful in the way indicating the presence of bands of adhesion, it is well to steady the part during their rupture by pressing firmly with the thumb on the painful spot. But during this process the behavior of tendons and bands of fascia, and of cicatrices, must be carefully watched; should the former tighten sufficiently to evidently impede movement, they must be divided, while, if the hindrance come from scars, these must be separated.

The *after-treatment* must at first be directed to prevent or minimize inflammatory consequences: entire rest must be secured, and cold, in the form of ice-bags, should be employed. If merely change of position have been the object of treatment, rest may be maintained until completion of the case: if mobility have been aimed at, passive motion must be employed on the third day, unless some inflammation have set in. This must of necessity be to a certain degree painful; if too much so, an anæsthetic may be again administered, and indeed, if necessary, reiterated.

In the manipulation of each joint, certain methods of movement should be adopted, and certain precautions used, which need only very brief mention, because the above general directions give a great part of what is necessary.

SHOULDER.—*Method.*—One hand is placed with the palm on the acromion; the fingers and thumb grasp between them the head of the humerus. The first movement is to be rotation outward and inward, effected by holding in the other hand, the elbow bent at a right angle. The arm is then brought in front of the body till the elbow lies over the lower costal cartilages, and then it is placed behind the trunk. Afterwards, circumduction is used in an increasingly wide circle.

Caution.—By no means let the arm be abducted directly from the side at an early stage of the process, lest it be dislocated downward.

ELBOW.—*Method.*—The patient lying on the back, the surgeon places his foot on a stool, so as to bring his knee on a level with the mattress. He receives the elbow in his hand, placed upon his knee, grasping with his other hand the forearm just above the wrist. While bending or straightening the elbow, he must press his thumb on the head of the radius, forcing it to follow the direction of either movement. When bending and straightening are sufficiently free, rotation must also be employed. When, but this is rare, it is necessary to divide the biceps tendon, the arm must be straightened as far as it will go, and the skin-puncture must be on the inner side.

Caution.—The chief danger is luxation forward of the radius, if the arm be incautiously straightened; when the biceps is contracted, the thumb must be used as indicated. Rotation must not be practised by grasping the patient's hand, lest the wrist be sprained; but by grasping the carpus and lower end of the forearm. The biceps tendon must never be divided unless attempted extension cause it to start well forward, so as to permit its section without endangering the artery or nerve.

WRIST AND FINGERS.—*Method.*—Inflammations of the wrist-joint that result in fixity, involve the fingers by thecal adhesions; these should be dealt with first. The surgeon places his thumb on the front of the middle phalanx, so as to steady it, while with his index and middle fingers he bends the stiffened ungual phalanx, his own and the patient's fingers being at right angles to each other. He then goes through the same manœuvre for the second phalanx; to move the first, it is best to grasp the bone at its condyles. The bend should be sudden and complete, applied at first to each finger separately, and then to them altogether, clenching the whole hand. Afterward, the metacarpo-phalangeal joint must be circumducted. In dealing with the wrist, the surgeon grasps the lower end of the forearm in one hand, and the carpus and metacarpus with the other, using his thumbs to make pressure on any painful spots. After flexion and extension, rotation must also be made free.

Caution.—At this joint, more than at any other, pressure on painful spots with the thumb, is essential, to prevent subluxation of a carpal bone. It is especially necessary to proceed at this joint by a succession of short, sharp jerks, after the fingers have been freed.

HIP.—*Method.*—The malposture of this joint is nearly always a combination of flexion with adduction. The patient is first placed on the back; the limb is grasped at the condyles, and by a series of jerks is bent up till the knee is not far from the mammary region; then it is brought down, both feet being placed on the table with the heels near the ischial tuberosities, and the knees are separated as far as they will go; afterwards, the thigh, placed in medium extension (in a line with the axis of the trunk), is abducted; during this last movement, the adductors will resist; the adductor longus and gracilis, together with bands of the pubic part of the fascia lata, will start into strong relief; they may require division, of which hereafter. Afterwards, full extension is to be enforced.¹ If the bands of adhesion, or the anchylosis, be very firm, it may not be possible to obtain the necessary power while the patient is on a bed or table; he may then be placed on a mattress on the ground, and the thigh may be manipulated as in Bigelow's method of reducing dislocation. To obtain complete extension is often impossible while the patient lies supine and at full length on the mattress; he may then be drawn to the end of the table so that his ischia are at the edge, his sound leg being

¹ By this term I mean a position such that the knee lies posterior to the lateral median plane of the body.

supported on a chair or by an assistant, while the surgeon presses the flexed thigh backward, taking care that the pelvis is properly fixed. Or the patient may be placed on his sound side, when the surgeon, placing one hand on the buttock, grasps the thigh at the knee with the other, and forcibly draws it backwards. These are the results which are aimed at, but I need hardly say that prudence generally renders it necessary to stop short of this ideal. Frequently, after a certain amount has been effected by operation, gradual extension, or a subsequent stretching, may enable us to gain a great deal more.

Myotomy about the hip may be pretty extensively practised. I have frequently carried the operation very far, with excellent results; but, unfortunately, the ilio-psoas, which is the chief agent in maintaining flexion, is scarcely within reach of the tenotome. Certain structures that aid in keeping up that posture can, however, be divided, permitting force to be more immediately exercised on the contracted muscle. These are the iliac portion of the fascia lata, its tensor muscle, and the tendon of the rectus femoris. To divide the former, the surgeon should observe, while extension is exercised on the limb, the extent of subcutaneous section to be made. Let the limb be flexed enough to relax the skin, which is to be drawn from the flank as much as possible outwards; the tenotome is inserted a little below and internal to the anterior superior spine of the ilium, its point being directed outward, and, as it passes on, the handle is to be raised a little, so as to let the blade glide around, close to the bone, to the front and upper part of the dorsum ilii; the knife now lies between the bone and the higher portions of the tensor vaginae femoris, and by causing the handle to pass in a semicircle downward, while the blade, taking the opposite course, is kept close to the crest of the ilium, the origin of the muscle is separated from the bone, while the thigh is extended as far as may be; afterwards, the edge is turned outward, towards the skin, and the fascia lata is divided, partly by pressing it down on the blade with the fingers of the other hand, partly by a sawing movement of the knife.

The tendon of the rectus femoris may be divided through a puncture either on its inner or its outer side; the latter is preferable. The skin should be shifted well inward, and the knife should be inserted about half an inch from, and a little below, the anterior inferior iliac spine; the blade must be sunk pretty deeply, and must go fairly under the tendon of origin; by carrying it upward while depressing the handle, that tendon is easily divided.

The adductors frequently require division;¹ sometimes only the superficial, sometimes the deeper ones likewise; the internal parts of the fascia lata must also in such cases be incised. The patient must lie on his back, and the limb be held in extension and in abduction sufficient to make prominent the tendon of origin of the long adductor, just outside of which the puncture is to be made. A rather stout tenotome being chosen, and the skin drawn well downward, the surgeon enters the knife a little outside that tendon, and so high that he feels the blade coursing along the surface of the bone. Turning the cutting edge inward, he not so much divides the tendon as peels it from the bone; this allows more abduction, and renders the gracilis tight, when its tendon is to be similarly dealt with. Now the fascia is found to be tight, not in one uniform plane, but in bands and puckerings here and there; these are also to be severed, but not very near the bone, especially in the male, lest the crus penis be wounded. The surgeon must now see whether the

¹ There is a condition, much more common in the female than in the male, of shortening of the adductors, independent of any joint-disease. Such patients cannot separate the knees, which sometimes even cross. Difficulty in micturition without wetting the thighs, the impossibility of cleanliness, and at a nubile age other inconveniences, render operative interference essential to social life.

amount of abduction gained by the above sections is sufficient; if not, he must examine the state of the deeper adductors, which, if tense and firm, must also be divided. He takes a tenotome, with the usual length of cutting-blade, but with a blunt portion from $2\frac{1}{2}$ to 3 inches long; he introduces this at the same puncture, just outside the adductor longus tendon, and placing his left index finger on the anterior part of the tuber ischii, glides the blade downward (the patient being in the supine position), until he feels its approach through the skin. Now the edge is to be passed, close to the bone, towards the margin of the ischio-pubic ramus, withdrawing it slightly at the same time, so that, by successive acts of sweeping inward and withdrawal, the long and short adductors are in great part peeled away from the bone. In some cases, it will then be found that the pectineus causes obstruction, when its outer fibres, the chief impediments, may be easily severed through the same puncture.

The operation completed, the patient is to be put to bed with the thighs well apart, and kept in that position by means of a sheet laid over them, with sandbags. If, previously, flexion was well marked, and has been with difficulty overcome, a firm, but not hard, horse-hair pillow should be placed under the buttocks. In some cases weight-extension may also be advantageously employed. Passive movement should commence early, if a movable joint be desired. It may, however, be necessary to repeat the induction of anæsthesia.

Cautions.—Such operations as these should never be undertaken too soon after the subsidence of hip-disease. When the original disease has been of long duration, and when there is demonstrably real shortening, with considerable projection of the trochanter, great caution must be used, since both the head of the femur and the acetabulum are probably much changed in form. To make sure that the pelvis is fixed, and does not follow the movements of the thigh, this must be more especially watched in extension (see page 498). In making sections of the muscles, the tenotome must be kept very close to the bone; if the division be made through the bodies of the muscles, some little distance from their origin, a good deal of blood is poured into the cellular tissue, and much ecchymosis of the inner part of the thigh takes place. This does not occur if the muscular origins be peeled away from the pubis and ischium.

KNEE.—*Method.*—The knee is commonly fixed in flexion; the muscles and fasciæ on the posterior part of the limb are shortened. The surgeon must first determine whether the patella is fixed to the condyles—generally, if at all, to the outer one; he must also ascertain if subluxation exists. If the patella be fixed by broad, bony ankylosis, the joint itself had probably best be let alone,¹ unless the surgeon is prepared to sever the patellar connection with chisel or saw; if it be attached by fibrous bands, these may be divided by a strong tenotome, passed carefully in the direction of the bony surface. This is best done by two punctures if the fixity be considerable and the attachments probably pretty wide; the one puncture should be at the upper outer, the other at the inner lower, edge of the patella; the knife from each should pass the whole length of the knee-cap, and should be carried obliquely inward and backward from the one, outward and backward from the other puncture, so that the two sections may meet in the position of the ridge that separates the two articular facets. After severance, the bone must be freely moved several times along over the parts beneath, to secure as much permanent mobility as possible. This operation should precede the main procedure by some days.

¹ Another device of treatment will be mentioned hereafter.

To *bend a straight knee*, is an easier and simpler operation than to gain good position in the opposite direction, and it is not attended with the danger of subluxation. The most convenient method I find to be this: Place the patient on a narrow couch, or, if such be inaccessible, on the side of his bed, so that the part to be treated may be next the edge. Choose a block or stool of such height that when the operator's foot rests upon it, his knee shall be on a level with the surface of the couch or bed. When the patient is thoroughly anæsthetized, his thigh is abducted at the hip and is laid across the operator's knee, resting upon it as upon a support, with the part just above the popliteal space. By grasping the leg a little above the malleoli, the surgeon has now ample leverage, and by successive small but quick jerks may bend the joint with facility, unless the ankylosis be very firm. The advantage which the operator gains by using his knee as a support is, that it acts as a gauge of the power he is employing, and prevents its becoming excessive, while his position is mechanically favorable.

To *straighten a bent knee*, the patient may be placed in one of two positions: (1) he may be on his back upon a sufficiently firm couch or mattress, and a certain convenience is obtained if this be only just wide enough for the patient to lie safely—for instance, unless ample manual aid be forthcoming, it may be advisable to secure, with a broad strap, the patient's thigh to the bed; or (2) the patient, when etherized, may be turned over on his face. This posture gives to the surgeon certain mechanical advantages, as the front of the thigh, upon which the counteracting force falls, is supported by the mattress. The objection to this posture is that much more difficulty is experienced in accurately noting the effect produced; hence I greatly prefer the former posture. In either case, the thigh being well fixed by bands or otherwise, the operator first bends the knee still further, and then by a number of short, sharp jerks impels it in the direction of extension. Two points have in the mean time to be watched, viz., that the tuberosity of the tibia really follows the forward movement, and that neither rotation nor lateral movement of the leg or of the thigh is produced. Moreover, I would point out that it is often wise to abstain from pushing a first operation too far. These points will be further considered immediately.

After a certain amount of rectification, according to the case, has been gained, further advance is often prohibited by a peculiar, elastic, yet invincible, resistance; and, on placing his hand on the popliteal space, the surgeon will feel the hamstrings, and probably also the fascia, very tense. Nothing further can be effected till these are divided.

For division of the hamstrings, the punctures should never be made in the popliteal space, but at the sides of the limb, on the outer side of the outer, and the inner side of the inner tendons. The subcutaneous passage should be pretty long, and the section made towards the skin as near the tibial insertion as possible. In performing this operation on the biceps tendon, the fingers of the left hand should be well pressed in, close to that part, so as to separate it from the external popliteal nerve. Often a band of fascia running obliquely down the popliteal space must also be divided.

Cautions.—If the patella be inseparably fixed to the femur, the propriety of interference is more than doubtful, unless the deformity be very considerable. Mobility of the tibia on the femur, the patella being fixed, is nearly always disadvantageous, since the patient has very little control over the lower leg in the direction of extension; whence it becomes a very unreliable support. If the flexion be such as to make the limb a mere encumbrance, an attempt to straighten it may be made, the patient understanding that he will have to wear an instrument for probably some years. But before undertaking such an operation, the position in which the patella is fixed must be ascertained; this

sometimes lies so low that, after very slight artificial straightening, the anterior edge of the tibia impinges against it. Such a mishap causes either cessation of further extension, or subluxation. In cases of considerable flexion, especially if combined with a certain amount of posterior malposition of the tibia, the great danger of efforts at straightening is the production of posterior subluxation. This danger is due partly to tension of the tissues behind the joint, but chiefly, I believe, to shortening of the anterior crucial ligament, which does not allow the upper end of the tibia to glide forward on the condyles during the act of rectification. When the slightest signs of this tendency appear, or, in other words, when the parts below the patella appear, while the leg is straightening, to become hollow instead of fuller, the movement must at once cease. Perhaps a little may still be gained by forcible downward traction from near the malleoli, or something further may be effected by placing a firm block behind the calf, and making pressure backward on the lower third of the thigh. Then the limb should be put up in plaster of Paris, and after a week or ten days another effort may be more successful.

In cases which have been preceded by long disease, it is necessary to be cautious lest so much of the anchylosing tissue be torn that not merely antero-posterior, but also lateral mobility may be produced. When tenotomy is practised, the punctures must not, as I have said, be in the popliteal space; this is to obviate a rent of the skin across the back of the joint, but it must be remembered that, if flexion be considerable, this may occur, even if there be no wound, especially if there be several cicatrices in the neighborhood. Deeper parts, such as the artery, have also been torn by too energetic surgery.

ANKLE.—Method.—The ankle is often stiffened by tendinous or perisynovial adhesions, which may, as a rule, be overcome with little difficulty; but when fixity results from firm bands, or false ankylosis in the joint itself, the condition is very refractory, because the astragalus is so short, and because the tarsal articulations lie so near the ankle-joint, that it is not possible to get an advantageous hold on the bone. If the joint be so fixed that the foot lies at a right angle to the leg, it is better not to use much force to break down the bands; the other joints become, after a little time, so flexible that immobility between the tibia and astragalus produces but little inconvenience.¹ But if the foot be considerably extended, more potent efforts are not merely justifiable, but desirable. In order to obtain a firmer hold, I am accustomed, in bad cases, to mould upon the sole a stout piece of poro-plastic felt, and to encase the foot in plaster of Paris and gum, taking care to leave space below and in front of the malleoli for flexion. A day or two after, the tendo Achillis is divided, and then with one hand at the heel, the other at the anterior part of the foot, flexion is carried out; but it must be remembered that, even with this contrivance, much of the force must fall on the calcaneo-scapoid joint. Considerable power may be used, but I am bound to say that, if the false ankylosis be close and firm, even great force may fail.

Cautions.—No other tendon than the tendo Achillis should be divided; none other is attached behind the ankle-joint, and nothing is gained by cutting others. It is imprudent to exercise much force without some such means as that above indicated, lest injury be done to some of the other joints, especially to the medio-tarsal. In case the deformity be distressing, and all justifiable

¹ The mobility of the tarsus is so considerable that fixity of the ankle-joint itself is not always easily diagnosed; if, however, the finger be pressed deeply in between the tip of the internal malleolus and the tibialis anticus, while an assistant alternately flexes and extends the foot, the head and neck of the astragalus will be found to move or to remain at rest according as the ankle-joint is free or ankylosed.

efforts at restoration have failed, the patient should have the option of undergoing a larger operation, such as that of partial excision.

TRUE ANCHYLOSIS of either *hip* or *knee* may occur in such a flexed position as to cause the limb to be very useless, and the patient to be exceedingly lame; a contrary condition at the *elbow*, viz., a straight ankylosis, renders the limb of very little value. Thus the question as to treating a true ankylosis must depend upon the amount of inconvenience produced. It must be remembered that a movable joint cannot be secured;¹ the question is only that of placing a motionless one in a better posture.

TRUE ANCHYLOSIS OF ELBOW.—An elbow ankylosed in a straight position may be placed rectangularly by dividing the humerus just above the joint; the part of the bone which lies between the olecranon and coronoid fossæ is very thin; all that is needed is to divide the two divergent pillars of bone that adjoin these fossæ on either side, but, owing to the position of the vessels and nerves, the operation requires some little care; it is best effected through two incisions, just large enough to admit a chisel one-third of an inch broad. The outer incision is made upon and a little behind the condyloid ridge, the chisel being driven inwards and a little forwards. The inner opening is made upon and rather in front of the internal condyloid ridge, and the chisel is directed outward and a little backward. The bone on each side is cut to about the depth of three-fourths of an inch, when the rest is easily snapped. The arm is now, while extension is kept up, to be bent to a right angle; to the outer aspect of the upper arm and to the back of the forearm, are to be secured, by plaster-of-Paris bandages, two gutters of metal, short enough to leave between them at the elbow a considerable interval which is bridged over by brackets standing well away from the limb, so as to allow of separate dressing of the wounds, without disturbing the position. The arm with this appliance is to be slung by pulley and counterpoise. The wounds should be healed in about a week, and the union should be fairly firm in a month; but a light retentive splint should be retained for some time longer.

[*Excision of the elbow* has been occasionally practised in these cases with the view of obtaining a movable joint. P. H. Watson and Annandale prefer partial to complete excision, and remove merely the lower part of the humerus.]

TRUE ANCHYLOSIS OF HIP.—When the thigh is bent at the hip-joint at an angle of 135° , and *a fortiori* at a less angle, the greatest inconvenience and lameness are produced, for the relief of which several operations have been devised and practised. To Dr. J. Rhea Barton, of Philadelphia, belongs the honor of the first attempt to rectify by osteotomy, in 1826, an angular, true ankylosis of the hip-joint; he sawed through the femur between the trochanters, bringing the limb into a straight position, and giving his patient a joint which continued movable for several years. Dr. J. Kearney Rodgers, of New York, modified this operation in 1830, by removing from between the trochanters a disk of bone. In 1862, Dr. Lewis A. Sayre divided the femur above the small trochanter, and removed a semi-globular piece of bone, with the intention of forming a new socket in which the truncated shaft might play.² In 1869, Mr. Adams sawed through the neck of the femur.³ In 1872, Mr.

¹ If ever such an event has occurred, it is so very exceptional as hardly to affect the question of practical prognosis; the advantage, too, could only be very doubtful, since muscular attachments are only planned for movement in a certain locality, and movement elsewhere would be more or less out of control.

² Lectures on Orthopædic Surgery, etc., p. 423.

³ A New Operation for Bony Ankylosis of the Hip-Joint, 1871.

Gant divided with a saw the thigh bone a short distance below the small trochanter.¹ In 1873, Volkmann introduced another method, removing a wedge from the outer part of the femur, and breaking the rest. Lately he has followed another more complicated procedure.² In 1879, I used the chain saw to divide the bone above the great trochanter, modifying Sayre's operation.³ Of these operations, most have been repeated: Sayre's, I believe, only by himself; Adams's, by many operators; Gant's, by Dr. John Ashhurst and others; Volkmann's, only, as far as I know, by himself; my own, by myself and Mr. Cantlie.⁴ [The late Mr. Maunder divided the bone below the lesser trochanter with a chisel.] A rather more detailed account may be given of these various procedures.

Dr. Rhea Barton made a rather large external wound, and simply divided the bone between the greater and lesser trochanters. In his modification of the operation, Dr. Kearney Rodgers took away a disk of bone, half an inch wide at its outer and three-fourths of an inch at its inner side. Dr. Sayre thus describes his operation:—

“An incision of about six inches was made over the trochanter major. The cut was slightly lunate, with the concavity looking downward. The lips were then separated, and the deeper structures, including the periosteum, were detached from the bone. A curved instrument armed with the chain-saw was passed around the bone, between the trochanters, and the femur first sawed transversely across. A roof-shaped piece was then sawed out of the upper fragment. In my second operation I sawed the curved section first, and should advise the operation to be performed in that way.”⁵

Mr. Adams calls his operation subcutaneous; a claim which, considering the in-and-out movement of the saw, cannot be conceded. It is an osteotomy with a small wound, and is thus performed:—

The instruments necessary are a knife in the form of a tenotome, but with a very long, rounded or blunt portion, and a cutting blade of a little over an inch long; also, a saw, constructed on the same model. Both these are provided with large, firm handles, usually pistol-shaped. The knife, introduced above and in front of the great trochanter, is carried downward and backward till it incises the periosteum and impinges on the bone; it is then withdrawn, the saw is substituted, and this works until the cervix femoris is severed. The tensor vaginæ femoris, the upper tendon of the rectus, and any other accessible resisting parts, are divided, and the limb brought down straight.

Professor Volkmann's method, first practised by him in 1873, is to make a rather long incision along the posterior edge of the great trochanter, to peel the periosteum from the junction of the neck and shaft as far as he can reach around the bone, to cut out with a gouge and chisel a wedge-shaped gap, and to fracture the rest; the femur is then brought down straight, and allowed to unite. His twelve patients all recovered with useful limbs.⁶ Lately he has introduced another method, whereby he hopes to obtain mobility at a new joint, which he endeavors to form by adding to the former procedure gouging out of the head and the remaining neck, rounding off the truncated shaft, and placing it in the reproduced cavity. Six patients thus operated upon by Volkmann are reported to have recovered with some flexibility at the false joint.⁷

My own operation is facilitated by the use of an instrument made on the model of a Belloeq's sound, but larger; the spring, which is sharp at its ex-

¹ Science and Practice of Surgery, vol. ii. p. 49.

² Beiträge für Chirurgie, S. 230.

³ Clinical Society's Transactions, vol. xiii. p. 421.

⁴ Dr. Ashhurst performed, on the same patient, Adams's operation on one side, Gant's on the other; [he has also operated, by one or other method, in fourteen additional cases, and in every instance with a satisfactory result.]

⁵ Op cit., p. 427.

⁶ Gross, System of Surgery, 6th ed., vol. i. p. 1095.

⁷ Ibid.

tremity instead of probe-pointed, can be entirely withdrawn from the canula. From near the top of the trochanter, downward on the outside of the limb, is made an incision $1\frac{1}{2}$ inches long, and extending down to the bone. Across the centre of this, another incision, equally deep, and slightly exceeding at either end the breadth of the bone, is drawn. The periosteum is now peeled away from both back and front of the bone, and as far as possible to its inner side. By passing the finger into the depth of the wound, behind the femur, the surgeon now can feel the small trochanter and the ilio-psoas tendon, above and outside which is a space bounded further out and higher by the curved femoral neck. The instrument above described is taken in the other hand and passed in front of the bone, and thence around it, until the finger-tip feels the end of the tube present itself in this space; the spring being protruded, now passes behind the bone, comes into sight, and is withdrawn, bringing with it a strong silk ligature which, in its turn, carries around the bone a chain-saw, with which the junction of the neck to the shaft is severed. In my cases I have found no occasion to divide the soft parts, either muscle or tendon, but have been able to bring the limb into position after some little traction. In the after-treatment the thigh should be much abducted, so that the necessary parallelism of the erect posture may cause depression of that side of the pelvis, thus compensating for the unavoidable shortening (see page 497).

Of these various methods the following must be said: It is of doubtful advantage to aim, by removing portions of bone, to procure a false joint. It certainly is very questionable whether a greater prospect of mobility is attained by such removal; it is probably the after-treatment rather than any other factor which determines the condition of mobility or the reverse. Nor is a joint, in the usual acceptation of the term, attainable; if such could be formed, it would not, I believe, be a very reliable support, since muscles are placed to maintain posture, or confer movement, at a particular part of the skeleton, and we cannot by art transfer the functions to another part. A firm, fibrous union, if strong enough to support the weight, yet flexible enough to permit some movement, would be useful; but, as said above, this is unattainable by removing portions of bone. Nor does experience show that the mobility, verified shortly after the operation, is persistent; the tendency has always been towards complete stiffness.¹

Thus, the method of Sayre and the second method of Volkmann I take to be unnecessarily severe, and in so far (Volkmann's certainly) unnecessarily dangerous.²

Gant's operation appears to be the mitigation of one deformity by the substitution of another; for the upper fragment is of considerable length, and, if the hip be flexed at an angle calling for operative interference, for instance, at something like a right angle, that fragment must protrude greatly, and the whole of its length be lost to the limb. [The Editor's experience with Mr. Gant's operation has led him to form a more favorable opinion of it than that expressed in the text. The bone-section being made but a short distance below the lesser trochanter, the projection of the upper fragment is inconsiderable, and the slight shortening is readily compensated for by the adaptation of a high-soled shoe.]³

Adams's operation, division of the neck of the femur with a saw, is very valuable whenever the surgeon can be sure that a sufficiently long neck exists. It is inapplicable to most cases of ankylosis occurring after hip-disease, by

¹ Such phrases as, "when last seen some mobility still remained, but was decreasing," are usual in the history of these cases.

² Volkmann considers that, in children, simple section, without removing any bone, may suffice.

³ [An interesting study of this subject has been published by the Editor's colleague, Dr. H. R. Wharton, in the American Journal of the Medical Sciences for July, 1883.]

which the neck of the femur is greatly altered—sometimes almost entirely absorbed (see page 499). There is, after the operation, considerable difficulty in bringing the limb down, and it would appear that in some cases very considerable division of the soft parts is necessary.

My operation is modified considerably from Sayre's, both in the shape of the external incision and in the direction of dividing the bone, which is obliquely upwards and outwards. I have performed it three times; Mr. Cantlie once. The limbs in the successful cases became very useful, and by keeping them well abducted during the after-treatment, they were, though shortened by actual measurement, but little shortened in appearance when the patients stood. The operation is by no means severe.

The statistics of several of these operations are as follows:—

	Cases.	Deaths.
Barton's and Rodgers's operations	15	6
Sayre's operation	2	1
Adams's operation ¹	33	3
Barwell's operation	4	1 ²

TRUE ANCHYLOSIS OF KNEE.—When a true ankylosis of the knee occurs in a straight line, or indeed at any angle more than 145° , it should probably be let alone; but if the angle be more acute, that is about 135° or less, the inconvenience is very considerable; moreover, the position in walking and standing is so bad that in young persons scoliosis is pretty sure to be produced. The choice of procedure ordinarily lies between two methods, for I assume that the plan practised by Dr. Gurdon Buck, of New York, and by Sir Wm. Fergusson, of excising a large wedge of bone from the angle, would now not be employed, or even come into question, save in exceptional cases, and a like observation may be made concerning Rhea Barton's method of sawing a wedge of bone from the front of the femur a short distance above the condyles; both operations are unnecessarily severe.

Brainard's suggestion (1854) of boring through the femur several times with a drill,³ and fracturing the bone, was in Pancoast's and Agnew's cases followed by severe suppuration. Brainard, in 1860, modified this proceeding, by perforating the femoral condyles themselves. These piercing and fracturing operations have been performed, as far as I can gather, seven times, with one death, but suppuration was frequent. In 1861, Professor Gross, of Philadelphia, extended the use of the drill to the anchylosing bone-substance itself, using a perforator one-sixth of an inch in breadth, and coming to a triangular or diamond-shaped point. This weapon he passes in different directions into the interval between the femur and the tibia, breaking down the intervening bone-tissue, or, if this be too firm, completing the section with a narrow chisel or Adams's saw. Seven cases, five of which were his own, have done well under this treatment, and in only one was the traumatic fever somewhat alarming.⁴ Dr. Gross points out that the operation is dangerous unless there is complete true ankylosis.

In 1875, I was, I believe, the first surgeon to use simple osteotomy above the condyles for the relief of angular, true ankylosis of the knee. Whenever

¹ Some of these with much suppuration and prolonged convalescence.

² My fatal case was that of a girl aged 14; a small portion of the lower segment became necrosed; the sequestrum could easily have been removed, but her nearest relative (uncle) declined to have anything done, would not even allow a resultant abscess to be opened, encouraged the child in recalcitrance, resistance to being dressed, etc. Her death is only attributable to obstinacy and indocility.

³ The use of a chisel and mallet to the anchylosed joint had been previously suggested by Malgaigne.

⁴ Op. cit., vol. i. p. 1099.

the leg lies at less than a right angle to the thigh, division of the tibia also is probably desirable in order to obviate deformity and inconvenient projection of the knee. I performed the double operation for a rectangular ankylosis some years ago, but believe that it is not necessary in all such cases if the subject be young; when the angle is acute, it will probably be desirable. The effect of division of the femur alone may first be tried, and, if replacement cannot be thus effected, or if it produce great tension of the skin, or sufficient pressure on the popliteal artery to sensibly affect the pulsation of the tibial vessels, the limb may be left at an angle of 135° , and complete rectification afterwards procured by division of the leg-bones.

The method of operating on the femur is this: For osteotomy of this description the surgeon requires, of peculiar instruments, merely a small mallet of some rather heavy wood, such as *lignum vita*, and a chisel. This latter must not like an ordinary carpenter's chisel be bevelled to the cutting part entirely from the face, but from both back and front, so that the lateral border is lancet-shaped. Two very important points the surgeon must test for himself, since instrument makers are much inclined to go wrong. The blade must not get thicker or broader above the bevel, since, if it do so, it is sure to get jammed while cutting the bone; indeed, if any difference in thickness may be allowed, the maximum should be just where the bevel begins. My chisel has these dimensions: At the lower, the cutting end, it is $\frac{9}{16}$ inch broad and just over $\frac{1}{16}$ inch thick. At the upper end it is $\frac{1}{2}$ inch broad and a shade less than $\frac{1}{16}$ inch thick.

When fully anesthetized, the patient is to be placed on his sound side,¹ and the limb of that side is to be drawn down quite straight, at both hip and knee. The other limb is bent, crossing over the sound one so that the inner condyle rests on a small bag of slightly moistened sand, which gives sufficient resistance to let the mallet-blows tell, and yet does not bruise the part lying on it. The ridge on the condyle which separates the articular facet from its outer lateral surface should be made out; a line or two above this is the most convenient place for operating.² A scalpel, with the edge looking forward, is passed through all the soft parts to the bone; the skin is best divided by pulling it backward with the other hand against the blade; by moving the point forward, well pressed against the bone, the periosteum is incised. Taking the chisel in the other hand, the surgeon slides it along the flat of the knife, still kept in place, until it is felt to come in contact with the bone, which must necessarily be at the periosteal wound. Now the scalpel is withdrawn, and by taps of the mallet, gentle at first, the instrument is made to bite, that is, to sink into the bone so deeply that it supports its own weight; after this, the mallet-blows may be a little heavier. By this means the chisel is driven in various directions into the bone, taking care between every four or five mallet-taps to loosen the instrument by moving it sideways, that is, across the axis of the bone, not up and down. Sometimes, in spite of all care, the chisel may get jammed sufficiently to require some force in loosening it, and in doing this it may be pulled a little too forcibly, and come out of the osseous wound. When this happens, it is very essential to make sure of its re-introduction into the same slit, as otherwise a thin shaving of bone might be severed, which would be very likely to become necrosed and set up suppuration. Thereupon the chisel should be quite removed, when the eye-end of a silver probe may be passed into the flesh-wound, and gently moved up and down till it falls into the osseous gap; along this the chisel is to be guided into its proper place, and the cutting may then recommence.

¹ I prefer operating from the outer aspect of the thigh.

² Even although disease have obliterated this ridge, there will be no difficulty in fixing the spot above indicated.

The operator must carefully watch the direction of his chisel, and the depth to which in various positions he has sunk it; and so must cut through, or very nearly through, all the circumference of the bone except at its posterior part, very near to which lies the artery. This part is to be broken by giving the leg a quick but not violent jerk, in the direction of flexion.

Extension, combined with traction, may now be employed to bring the limb either straight or half-straight, according to the directions above given, and while it is held in this posture, a plaster-of-Paris bandage is applied and allowed to harden, the greatest care being taken in regard to position, not merely as to the degree of extension, but also as to the position of the foot. Rotation of the tibia on the femur not unfrequently occurs during knee-joint disease; osteotomy affords an opportunity of correcting it.

Nothing has as yet been said about dressing the wound, because on that subject, and on the desirability or otherwise of the spray, etc., I wish to say a few words. A year or two ago, I used to perform all my operations under the spray, and dress the wound with all the Listerian complications. I never do so now, and I believe that the wounds heal more quickly, and certainly the patients have less pain. Under Listerism, the many folds of gauze make a great lump at the place of operation, and this renders it rather difficult to judge of the symmetry of the limb. Also, a window has to be made in the plaster-of-Paris case, for removing the drainage-tube and redressing the wound. I now treat my cases on a less complicated system. Immediately after fracture of the bone, the wound is syringed out with a saturated solution (five per cent.) of boro-glyceride; a few strands of catgut are introduced about half an inch into the wound, to act as a temporary drain; a thin pad of cotton-wool, soaked in the same fluid, is laid over the wound; through the middle of this pad is placed an India-rubber tube, one-eighth of an inch in diameter, and two or three inches long; the plaster-of-Paris bandage is then applied, but, when it reaches the level of the wound, a piece of copper tubing is slipped over the India-rubber, so that it may not be compressed and thus rendered impervious. I call this my irrigation-tube; through it I inject, with an ordinary glass syringe, about a drachm of solution of boro-glyceride, daily for the first three days, afterwards only occasionally. Since I have devised this method, I have never seen the wounds, but I believe that they have all healed in about six days. This plan is a great saving of time and trouble to the surgeon, and saves pain to the patient, since in using the Lister method, a window has to be made some time during the first week, and it is just during this period that, although while the limb is still it is quite comfortable, movement gives a good deal of pain.

To place entirely straight, after simply dividing the femur, a knee which has been fixed at an acute angle, is rarely wise (see p. 530); even if all danger of gangrene from compression of vessels be disregarded, and though we may feel sure of firm union, yet the subsequent pain, for a certain period, is the more severe and the more prolonged, the greater the change in

FIG. 625



True ankylosis of knee.

the posture of the lower femoral fragment. It is better, therefore, to let from a month to six weeks, according to the age of the patient, elapse, and then divide the leg-bones.

It certainly is better to divide both fibula and tibia, rather than the tibia alone, while fracturing the former by mere manual force. Just a little below its head, the fibula dwindles down into a very thin neck. Choosing a spot just below its head, and a little behind the bone, the knife is sunk and the chisel glided down to it; two or three taps with the mallet will so far weaken it that it may readily be broken by pressure with the thumb. The surgeon now finds a place on the inner posterior edge of the tibia, on a level with the lower part of the tubercle; here the head or tuberosity of the tibia ceases and the shaft begins. It is almost subcutaneous, so that the knife followed by the chisel reaches the bone very easily. From this point it is driven in a direction forward and a very little outward; then, being almost withdrawn, it is directed more backward, but still outward and a little forward. A very slight backward twitch will fracture the rest, the knee and recent line of union of the divided femur being held firmly. The same bandages and modes of dressing are used as after the previous osteotomy.

Fig. 626.



True ankylosis of knee after division of femur.

Fig. 627.



The same limb after division of tibia and fibula also.

This mode of treating ankylosis is very successful and extremely satisfactory. Very remarkable is the slight amount of deformity left by an operation which must bend a bone, normally straight, at a very considerable angle. Let us, for instance, assume that a knee is ankylosed at a right angle; the femur is divided and the tibia brought to lie in a line with the femur.¹ To effect this, the bone must be bent at a right angle at the place of section. At first (as in Fig. 627), a considerable inflection is perceptible, but

¹ Strictly, in a line parallel to a prolongation of the axis of the femur.

in a month or two the divided bone appears quite straight; the entering angle, the soft parts being lifted away, appears to become filled up, and the salient angle, pressed up by soft parts somewhat stretched, to become absorbed. Thus the ultimate result—that is, about four months after the photograph was taken—showed in this case of double osteotomy a straight limb without deformity of either segment.

Under certain unusual conditions osteotomy might be required at the *shoulder* (upper end of the humerus); or at the *ankle* (lower end of the tibia and fibula), for ankylosis of the foot at an awkward angle.

NEUROSES OF JOINTS.

(Hysterical Joints.)

The nature and pathology of hysteria hardly lie within the scope of a surgical work; but I may be permitted to say that the name is somewhat unfortunate, because, first, although chiefly manifested in, it is not absolutely confined to, the female sex; and because, secondly, it frequently occurs without owing its origin in any way to the uterus or other genital organs. Nevertheless, the malady is most common where some cause of uterine irritation may be traced. Thus, certain women are always hysterical when pregnant, and never at other times; some are hysterical just prior to the appearance of the catamenia, the symptoms ceasing when the flow is fully established; some prostitutes are always strongly hysterical. These instances furnish distinct evidence of genital irritation; but the larger number of cases, though not as a rule the more violent ones, are furnished by unmarried maidens, between the ages of 17 and 30, and in a goodly proportion of such cases amenorrhœa, dysmenorrhœa, or a slight degree of menorrhagia, is present. Sometimes ovarian pain, in all probability produced by congestion, can be detected; and, in many cases, there is a history of misplaced or disappointed affection. But, on the contrary, many hysterical persons have no uterine malady whatever, nor, as far as can be ascertained, any disappointment. Both women and—but far more rarely—men, reduced by long and wearing disease, may be affected by that form of causeless, or almost causeless, weeping, which we call hysterical.

The forms which hysteria takes are two—viz., hysterical paroxysm and mock disease. The two are rarely coincident and simultaneous, but the latter not unfrequently succeeds the former; and I have known a good strong fit to dispel most obstinate articular and spinal hysterical neuralgia.

Although no period of life, after puberty, is exempt from liability to this neurosis, yet there are some differences and peculiarities at different ages. Young women—that is, from 17 to 25—are more subject to the paroxysmal form. After 25 (unless in pregnancy) the tendency is more towards mock disease. If at the younger age some local malady be simulated, it is rather more commonly of the spine than of a joint; and if of a joint, the hip is most usually affected. Again, the hysterical neuralgia of the young is of an acute kind—the pain is described as “horrible,” or “awful;” that of the more mature has the characters of a chronic disease.¹

A peculiarity of all hysterical symptoms is this: That any moderate excitement or shock, whether of joy or grief, may excite or bring them on, whether previously quite absent or merely slight. But a violent shock, as

¹ Numerous exceptions to these aphorisms occur. The malady is protean, and it is only possible, in so variable a disease, to indicate the prevalent conditions.

terror, horror, or the necessity of escape from imminent danger, often banishes the malady suddenly, at least for a time. One of the mental states which seems most frequently thus to influence the neurosis is religious fervor and excitement, combined with the presence of some visible or tangible object of faith. Many, indeed the majority of patients, have a certain control over their pains and troubles—can either repress or aggravate them—and they are themselves more or less conscious of this power. If by the indulgence of compassionate but over-anxious friends they are encouraged to make the worst of their pains—to fret over and nurse them—they will almost inevitably get more severe; while a firm but not unkind ignoring, or at least not fostering, of their troubles, tends greatly to their alleviation.

SYMPTOMS.—Very rarely are any joints attacked with hysteric neuralgia, save the hip and the knee. Three points are more especially characteristic, viz., absence of inflammation or swelling, presence of much pain with extreme surface tenderness, and anomaly in location.

In regard to inflammatory signs and swelling, their absence must not be taken as absolute, for occasionally a slight redness and a very little swelling may be detected; but not at first, only after the pain has lasted some time. The *redness*, if it occur at all, is evanescent, and in some cases vanishes a few minutes after the part is exposed to the air, and perhaps may return again before the examination is over; it certainly seems to me to come on when the patient's attention is strongly fixed on the part. The *swelling*, if present, is merely dermal; it may be moved over the subcutaneous parts, and therefore, though visible to a trained eye, can hardly be felt or verified by tape measurement. *Heat* is absent, unless it have been artificially produced by rubefacients or by warm coverings to the limb. The fourth symptom of inflammation, *pain*, is abundantly present, according to the patient's account; and in consequence of this pain she declares herself to be lame.

Now, since all signs of disease except pain are absent, or only very slightly marked, it follows that any conclusion as to the disease is chiefly to be drawn from studying the accounts which the patient gives of that symptom. In this study, some little management and tact are necessary; when, for instance, a girl or young woman between the ages above specified, complains of a joint, which, without sprain or other traumatism, without rheumatism or cold, has become rather suddenly painful, the surgeon, without prejudging the case, should have in his mind the possibility of hysterical neuralgia; having ascertained the history, whether or no the uterine functions are well performed, and whether the suffering increase about the catamenial periods, he may let the joint be uncovered, and, looking at it a while, may very gently brush his finger-tips over the surface. If this act cause a start, and an expression of pain, his suspicions will be much confirmed. Afterwards, the patient may be questioned as to the painful localities; these will nearly always be found to differ from those of real disease. Moreover, if the flat hand be laid very gently on the spot indicated, and then the pressure be slowly increased, even until it is pretty considerable, it will be found that the heavier is better borne than the lighter contact. The joint-surfaces may be pressed, even jarred together, without eliciting any complaint, as long as the superficies of the joint be not touched, more especially if the patient be made to believe that an examination of some other part of the limb is being made. In some cases, movement is painless, and occasionally free within certain limits; in other cases it is resisted by voluntary or emotional muscular contraction, the signs of which are evident to both eye and hand. But—and this is an important circumstance—movement produces in many hysterical joints a fine, slight crackling, which might, unless the fact were known,

mislead diagnosis; it is to be remembered that certain joints of persons between fifteen and eighteen, the age of greatest growth, habitually crepitate in this manner. A coarser crackle may sometimes be detected in old long-standing cases of hysteric malady, more especially in such as have been treated as though affected with real disease. Moreover, the limb segment above the joint does not waste; it is true that if the patient have been long laid up, and have not used the limb for some time, it may be slightly smaller than the other, but not in the same way or degree as in organic joint-disease. The flexors are not tighter nor harder than the extensors; usually, indeed, the latter are the more contracted. These points should be examined in two ways: the one, while the patient's attention is fixed on the joint; the other, while it is, as far as possible, diverted by conversation in some other direction, when the formerly rigid limb will often be seen to relax, or the previously very sensitive joint may be touched with impunity.

Certain points of difficulty arise when the hip is the affected joint; but some astuteness in the method of examination will eliminate them. The patient being probably in bed, the posture (lengthening, shortening, and flexion) is to be visually noted. If, now, the hand be passed gently over the region of the great trochanter, great manifestation of pain will occur; if the surgeon take the knee, and endeavor to move the femur, it will probably be rigid; but rigid by means of great tightening of muscles—the thigh and nates may be felt hard and resilient. Nevertheless, if the limb be watched during subsequent procedures, it will not be found to maintain a constant angle with the pelvis. Very often, if the patient's attention be directed quite otherwise, one may, by grasping, not the thigh or knee, but the foot, place the limb, unsuspected by the patient, in various different positions, without moving the pelvis. The first posture-symptom of true hip-disease is nearly always that of lengthening; in hysteric hip, the first change, if any, is that of shortening, in the great majority of instances; but it is excessive in regard to the other symptoms, while some parts of the posture itself are exaggerated; the buttock is thrown too violently back, but the nates, instead of being loose, are tense, and have not that increased breadth characteristic of the real disease in this stage. The spine is also excessively curved and twisted. Very often the patient stands thus, but with the foot lifted from the floor—a position which I once saw in sacro-iliac disease, but have never seen in hip-disease. If the patient be left standing, with some such support for the arms as the back of a chair, and if other conversation be introduced, one sees, as fatigue begins, the malposition gradually grow less; but if a word be said shortly and sharply about the change, it will almost suddenly return in its former intensity. These signs may not all be present in any one case—a peculiarity of hysteria is variability—but some of them will exist, while the limb-wasting is invariably absent.

While wishing to emphasize the necessity of examining the patient so as to put her off her guard, I would also deprecate any questions or observations which might indicate to her the true symptoms. The most difficult cases are those which have been already submitted to much examination, which has enlightened the patient; especially difficult, both to recognize and to cure, are such as under mistaken diagnosis have already been treated for a considerable time by the use of splints, rest, blisters, etc.

TREATMENT.—A very great part of the management of hysteric joint-disease must depend on the absence or presence of any uterine affection; dysmenorrhœa and amenorrhœa must of course be treated according to their cause; menorrhagia, or, which is more common, slightly excessive and too frequent menstruation, should at once be stopped by the use of such astringents

as gallic acid, or, which generally answers the purpose, of the Indian hemp. But if no uterine trouble be traceable, it is, I believe, a mistake to give emmenagogues or other medicines directed to the womb. As a rule, under these circumstances, aloes and iron, myrrh, etc., tend rather to increase the trouble by augmenting the pelvic, and therefore the ovarian hyperæmia.

Certain remedies are frequently valuable, their use being guided by the robust or anæmic condition of the patient; in the latter condition, iron (without aloes) may be advantageous. With this remedy, alternating with quinine, strychnia, or other bitter, valerian or valerianate of zinc, or bromide of potassium, may be combined. Bromo-camphor is doubtless also capable of yielding good results. In the robust, the applicability of tonics is more than doubtful, especially of iron, aloes, or any medicine which may produce hyperæmia of the pelvic organs. Local treatment, such as is applicable to inflammatory joint-disease, is only hurtful in the mock disease. The utmost to be done in this direction must be the use of a chloroform or belladonna liniment, and even this as a rare exception, since whatever calls attention to the part must be avoided; yet sometimes a little yielding to strong imagination must be conceded.

I have had occasionally very marked success by the contrary device, viz., by attracting the patient's attention to another part. Thus a little seton may be passed subcutaneously a good way from the seat of disease, particular directions being given as to the method of managing and dressing it, with some little mystery about its use, and the assurance that when the thread comes away the limb will be well. In one case that I saw, the girl had been told that her knee must be excised, and on this she had fixed her mind; the case was most obstinate. At last chloroform was given, and a longitudinal incision made through the skin on each side of the joint; it was put up in splints, she firmly believing that some severe operation had been practised. In about a month, when the wound had healed, the neuralgia ceased. A year ago I treated a young lady in this way, but made a smaller cut on the outside of the joint; she also got quite well. There are other ways in which the imagination may be used—and often by designing persons misused. Entire and implicit trust in a certain set of remedies, or even in a certain person, or, as has more than once happened, in a certain spring or relic, has cured hysteria which has resisted all other means.

In the worst cases, the plan introduced by Dr. Weir Mitchell¹ may advantageously be employed.

ARTHROPATHIES FROM INJURIES AND DISEASES OF NERVES AND OF NERVOUS CENTRES.

Diseases of joints consecutive to and produced by morbid conditions of nervous trunks and centres, form a subject still full of obscurity and difficulty, although of late years much light has been thrown on the subject, in one particular direction, by the labors of Charcot, Weir Mitchell, Ball, Westphal, and Buzzard.

The first step in this direction was, I believe, taken by J. K. Mitchell, of Philadelphia,² who, observing a remarkably obstinate case of acute or sub-acute rheumatism in a woman with angular curvature, resolved, after the failure of all the usual remedies for rheumatism, to treat it as due to spinal irritation or inflammation. His measures were rapidly successful. He after-

¹ Lectures on Diseases of the Nervous System, especially in Women. Philadelphia, 1881.

² On a New Practice in Rheumatism. *Am. Jour. of the Med. Sciences*, O. S. vol. viii. p. 31. 1831.

wards treated three other cases of rheumatism on the same principles. Their success led him to conclude that rheumatism was a spinal neurosis, and his theory met with a certain support; nor is it at the present day forgotten or negatived. Whether this view of rheumatism can or cannot be maintained, it is evident that the doctrine of a neuropathy producing an arthropathy was here distinctly formulated.

In 1846, Dr. Scott Alison read, before the Medical Society of London, a paper on arthritis occurring in the course of paralysis.¹ Two cases are described, the patients in both having been perfectly healthy until attacked by hemiplegia; in both, after a few days, certain joints (wrist, knee, foot) became swollen and painful. Both patients died; and it is much to be regretted that, although autopsies were made, the joints do not appear to have been examined. A case recorded by M. Vigues is in this connection of primary importance. A man received a sword-wound, which divided the left lateral half of the spinal cord, producing paralysis, with preservation of sensibility of the parts below. After the lapse of twelve days, considerable swelling of the whole extremity was observed, and shortly afterwards hydrarthrosis of the knee-joint. In two days this was followed by sloughing bed-sores over the right buttock and right half of the sacrum.² Weir Mitchell relates the case of a soldier who was, at Gettysburg, wounded over the outer part of the right clavicle, the ball passing out over the scapula; the paralyzed condition of the arm showed that the brachial plexus was involved. The joints of the fingers and wrists afterwards became slightly swollen and excessively tender to movement, but ultimately recovered under the use of the induced current.³

These cases show that, in consequence of paralysis from disease or injury of the nervous centres or trunks, joints lying in the course of supply may become the seat of certain forms of disease, concerning the nature of which we have no very clear anatomical data, but which clinically may be described as belonging to two categories: The one is inflammatory, leading to considerable effusion into the synovial sac, and generally yielding after a certain time; the other, also inflammatory, is accompanied by less effusion, but tends to the production of ankylosis. Either form of disease may follow any sort of lesion—gunshot, incised, or punctured wound—of the cord or of nervous trunks; or, indeed, such bruising as may be produced by dislocation or by efforts at reduction;⁴ or again by disease of, or pressure on the cord, as by angular spinal curvature.⁵ At first the paralysis, especially if rapidly produced, is accompanied by cutaneous thickening, œdema, and other signs of impaired nutrition, which may mark any deeper disorder; then, after a few days, the joint-malady, being more persistent, becomes apparent. Indeed, it is probable that the joint-disease does not commence till the tenth or twelfth day; it is then found either to affect several small joints, as those of the fingers or toes, or, if it attack a large articulation, to be usually limited to that one. The swelling is sometimes trifling, sometimes, especially if a large joint be affected, considerable (effusion); the skin is somewhat reddened and perspires freely. Generally, flexion rapidly supervenes, but I have known considerable over-extension to occur in the fingers. Extreme tenderness both to touch and movement is usual. This condition is very obstinate, and may outlast by weeks all other symptoms of the injury. If, for instance, this have been a bruising or wounding of nervous trunks, even after all evidence of inflammation has subsided, the joints may remain stiffened and painful on movement, and indeed, may not recover their whole range of mobility until after

¹ Lancet, 1846, p. 278.

² Journal de Physiol., t. iii. p. 47.

³ Injuries of Nerves, p. 169. Philadelphia, 1872.

⁴ Weir Mitchell, op. cit.

⁵ I am not aware that any joint-disease has been observed in connection with slow pressure on nervous trunks, such as occurs in cases of tumor or aneurism.

several years. The second form of disease, above referred to, not only affects the joints differently, but, apparently, rather the deeper structures. It commences later in the course of the paralyzing disease or injury, with less swelling, which is of a firmer and harder description, and with considerable pain, even while the parts are at rest, but greatly aggravated on the slightest movement. There is great tendency to contraction, and in these cases it appears almost impossible to prevent ankylosis. Mechanical appliances and passive motion are not only unbearable, but appear rather to increase than diminish this tendency, and in the large majority of instances the surgeon has no choice but to retain the limb in such a posture as may be most convenient for the stiffened joint. This obstinate tendency often continues, even though the paralysis may get well.

I cannot but look on these arthropathies as simply the result of disturbances of nutrition and secretion, the vaso-motor or sympathetic portions of the supplying nerves being at the first powerfully involved, and their affections being more persistent than those of the other nerves. This view is borne out by the frequency of ulceration and sloughing in these cases, especially at spots upon which pressure may fall, as in M. Vigùès's case above quoted. Hyperæmia, in some cases at first active, but soon becoming or being from the first passive, produces excess of synovial secretion followed by deficiency and thickening. If the nervous malady still persist, destruction of cartilage, and even of bone, may follow, just as œdema, ulceration, and sloughing may occur in the ordinary connective tissues.

But if the arthropathies of hemiplegia and paraplegia exhibit no, or but slight, special characteristics, the joint-affections of another nerve disease are very differently circumstanced; especially is *tabes dorsalis* or locomotor ataxia distinguished by occasionally producing very remarkable and peculiar conditions of the joints. The profession is indebted to Professor Charcot¹ for calling attention to and giving excellent descriptions of these affections. The papers of Ball,² Riche, Bourneville, and others, are also of great value. We cannot but believe, from a careful examination of the records, that the joint-malady is a more frequent accompaniment of locomotor ataxia, as it appears in France, than in either England, Germany, or America. Nevertheless, the excellent work of Dr. Buzzard³ and the contributions of Clifford Allbutt,⁴ in England, of Ponfick, Hitzig, and Westphal,⁵ in Germany, and of Weir Mitchell, in America,⁶ show that these conditions exist, and that more instructed attention may lead, in these countries, to the recognition of a greater number of cases than have hitherto been recorded.

The joint-trouble begins generally towards the end of the first period of the disease; that is, when the "lightning pains" have lasted some time; and either before or very shortly after incoördination shows itself. Occasionally, the arthropathy is still earlier, and may be, as in the second case of Charcot,⁷ contemporary with the first attack of the characteristic pains. One of these periods of manifestation is certainly the invariable or almost invariable rule in the lower extremities, but it may be much later in the upper, because the malady is generally a long time advancing upwards from the inferior parts of the cord.

¹ Lectures on the Diseases of the Nervous System. New Sydenham Society's translation. London, 1877-1881.

² Gazette des Hôpitaux, 1868-9.

³ Pathological Transactions, vol. xxxi. p. 193, and Clinical Lectures on Diseases of the Nervous System.

⁴ St. George's Hospital Reports, 1869.

⁵ Berliner klinische Wochenschrift, Nos. 46, 47, 53, 1872; No. 29, 1881.

⁶ American Journal of the Medical Sciences, July, 1873.

⁷ Op. cit., vol. ii. lect. iv.

The patient, at the particular period of his disease which has been mentioned, discovers one day that a limb is greatly swollen; the swelling gives no pain, and is unaccompanied by fever; examination reveals the presence of much fluid in the joint as well as in the surrounding parts, and a crackling sound is emitted on movement. In a few weeks all these symptoms may disappear, leaving the limb in the same state as before, save the crackling.

In other cases the attack comes on as above without prodroma of any sort, except, in some cases, a slight amount of crackling. The swelling may run the same course, and may disappear in the same manner; but the joint is no longer normal. It may be simply deformed; it may permit manifold and irregular movements; its ligaments and capsule may be much relaxed; the joint-surfaces may be greatly altered; or with, and, indeed, in consequence of, these changes, the limb may be dislocated. Again, and this is a most important factor in our appreciation of the disease, in certain cases the bones become exceedingly fragile and break with extreme readiness, the fractures readily uniting, but with exuberant and badly-formed callus. The diseased parts are remarkably free from pain, and, indeed, patients use their limbs, and even walk, in spite of the extreme changes now to be detailed.

MORBID ANATOMY.—On examination, the bursæ around the joint are found large and relaxed, having evidently been greatly distended by fluid which had afterwards been absorbed. In one case¹ the periarticular tissues are described as of a blackish color (*noirâtre*); they are occasionally, in part, converted into bone or cartilage. The ligaments and capsule are distended and relaxed. The synovial membrane, thickened, grayish, and without dendritic fringes, contains sometimes a thick, citron-colored, sometimes a puruloid, synovia. In some cases false bodies, varying from the size of a pea to that of a pigeon's egg, lie in the articulation.² The cartilages over the whole or the greater part of the surface have disappeared, and the bone itself presents the appearance of being worn away. It is, in some cases, rather rough and furrowed; in other cases, or at other parts in the same case, it is polished though not eburnated. Around the joint are frequently osteophytes, and sometimes out-growths from the margins of the articular surfaces. A case reported by Dr. Buzzard, showed a very singular condition which appeared like the ossification of a tendon; no opportunity for anatomical examination has as yet occurred, but the result of Dr. Buzzard's careful clinical study may here be quoted:—

“W. is a man aged 30; if we let him lie upon his back, and measure the distance from the anterior superior spine of the ilium to the tip of the internal malleolus, the tape shows a length of $33\frac{1}{2}$ inches on the right side, whilst it indicates $35\frac{1}{2}$ inches on the left. When the right foot is grasped, a moderate amount of traction easily reduces this disparity to one inch. On the other hand, when he stands with his bare feet on the floor, the difference in length is increased to three inches. As he lies, there is no marked inversion or eversion of the right foot, which tends, when it is absolutely left to itself, to roll slightly outwards; but he can easily control this movement, and even invert his foot with the greatest ease. He can extend his right lower extremity perfectly well, but flexion of it upon the trunk is limited; other movements are easily performed. The upper and inner surface of the right thigh—Scarpa's triangle—is distinctly rounded and prominent as compared with the corresponding part in the left limb, which presents the normal hollow. Turning to the hip, the patient being still recumbent, we find that the great trochanter is as nearly as possible on a level horizontally with the ilium, being evidently carried upwards by muscular action. The neighborhood of the hip is bulged and deformed by what examination with the hand ascertains to be a large collection of fluid in or about the hip-joint. If we lay hold of

¹ Ball, *Gaz. des Hôpitaux*, 1868, p. 507.

² Westphal, *Berlin klinische Wochenschrift*, 1881, S. 415.

the man's thigh near the knee, we can easily, with the advantage of the leverage thus obtained, move the bone into all sorts of positions, forcing it upwards or downwards, and rotating it in and out. These movements, indeed, are very much more easily carried out, and to a greater extent, than in health. But do what we will, the other hand placed upon the swelling can discover no trace of any neck or head to the femur. The bone evidently terminates above with the great trochanter. In some of the movements, especially in rotation outwards, we are conscious of crepitus, which is sometimes much more marked than at others. The patient says that he often himself feels this crepitus in the movements of walking. Turning back now to the front of the thigh, and examining the structures below Poupart's ligament, we come upon something which is very singular. We feel a sort of narrow, bony splint, not wider than one's little finger, which stretches obliquely downwards, and somewhat inwards, for about nine inches. Above, it is pretty firmly fastened (not, however, apparently by bone) to the anterior inferior spine of the ilium, but lower down it can be easily grasped, lifted from subjacent textures, and slid loosely to and fro. When the patient extends his leg, this process of bone is held tightly, so that it is evidently connected in some way with the quadriceps femoris muscle. It appears, in fact, to occupy the position of the superior tendon of the rectus. Besides all this, we note that both lower extremities are somewhat wasted, the right especially."¹

If at some future period an anatomical investigation shall corroborate Dr. Buzzard's view as to this growth of bone, it will be, as far as I know, the only instance of ossification of muscle which has been observed in this very curious disease.

The anatomical changes just noticed show only a distant resemblance to those of arthritis deformans; the predominance of wearing away, the comparatively slight production of osteophytes, and the tendency to complete luxation, mark a very real difference. If the knee here represented (Fig. 628) be compared with a like articulation affected with arthritis deformans, there can be no confusing the two diseases, even though some amount of marginal hyperplasia is to be traced about the

Fig. 628.



Bones of knee-joint; tibia worn away by patella; hyperplasia of articular margin. (After Schreiber.)

Fig. 629.



Upper end of humerus worn away.
(After Charcot.)

femoral surface. In no other joint-disease can there be found such complete wearing away, as is shown by the upper extremity of the humerus here represented (Fig. 629).

¹ Op. cit., p. 225.

The joint-malady then in its commencement (its benignant form) depends on a change in the nutritive condition—probably a profound disturbance in the functions of the vaso-motor nerves, which permits distension of vessels, arterioles, and venules, with great passive hyperæmia—whence painless but very considerable œdematous swelling, not merely of the joint, but of the whole limb. The condition is, in this benignant form, transitory, for the spinal disease itself is not progressive in a regular and uniform manner; the nerves supplying the vessels may regain their influence; the local disorder may gradually disappear.

The malignant form commences in the same manner, but the nervous defect, and therefore the local troubles, are persistent; the disorders of nutrition continue, resulting, as we have seen, in such a condition of the bones that they break with the greatest ease, or become worn away wherever subjected to friction, as in the knee under the patella, or at the joint-ends, as in the humerus above depicted. When the heads of bones have thus become worn down, and when the edges of cavities have disappeared, luxation is very readily produced, especially when the ligaments and capsules also have become lax and softened by previous distension. Although, therefore, it is at the joints that the malady has chiefly been observed, this, probably, is merely because of their mechanical value in the functions of movement, and because of the mechanical effect of such motion. The diseased condition is not confined to the articulations, but extends to the whole mass of the bone—indeed to the whole limb supplied by that portion of the spinal cord which is in a certain state and stage of disease.

At present, the peculiar central disease which produces arthropathies, has not been differentiated from the general changes of tabes. Many years ago Charcot believed that certain changes in the large cells of the anterior cornua might be the primary cause of these arthropathies, but changes very similar or identical with those which he indicated, have been found in ataxic patients without joint-affections. In one case of articular disease occurring very early, Westphal found the posterior columns degenerated (gray), but in most atopsies no central lesions which in our present state of knowledge we can directly connect with the joint-disease, have been discovered. The assumption that there may be “in the medulla oblongata a centre directly concerned in the nutrition of the osseous skeleton,” is as yet hardly within the range of scientific physiology. We must be content to leave the deeper pathology of all arthropathies originating in nervous disease or injury, till a larger number of facts shall yield a clearer clue to their interpretation.

SYMPTOMS.—The joints are liable to affection in this order of frequency: (1) knee, (2) shoulder, (3) elbow and hip equally. Small joints are rarely affected. The attack, always sudden, is ushered in by no prodromata save that, in some cases, a crackling in the joint, in some a severe bout of “lightning pains,” in others a quick pain like a strong electric shock, causing a fall, have preceded the joint-attack. Prof. Ball and Dr. Buzzard connect acute visceral disturbances with the arthropathy, Ball having found that a quarter of the joint-troubled patients with tabes, 4 in 16, were also affected with *crises gastriques*,² while Buzzard found 8 out of 21 who were thus affected. The proportion, even according to Buzzard’s figures, is too small to establish any close relationship, especially as Westphal³ says that he has seen many patients without arthropathy suffer from similar visceral affections.

Some morning, generally at the end of the first period of ataxia, the patient

¹ Buzzard, Pathological Transactions, vol. xxxi. p. 268.

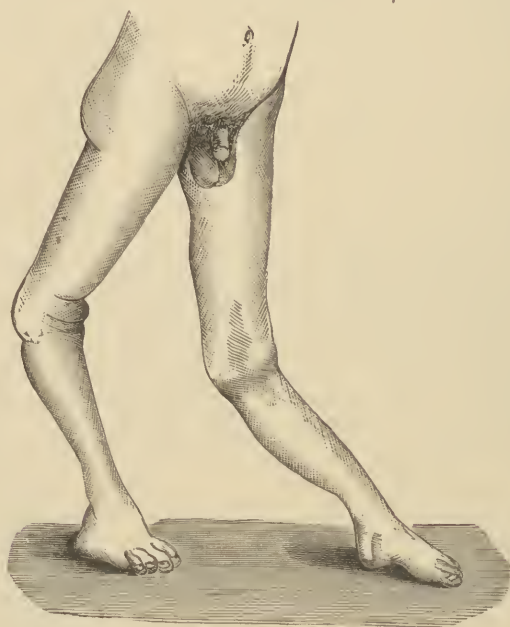
² Gaz. des Hôpitaux.

³ Loc. cit.

awakes with a limb greatly swollen, the enlargement being most marked on a level with the joint, where also it is most clearly œdematous or fluctuating; the neighboring parts are more brawny, and only pit on prolonged pressure with the finger.

The tumefaction, although some exceptions to this rule occur, is absolutely without pain, redness, or other inflammatory symptom; neither is there any pyrexia.¹ This condition is only transient; when it disappears it may leave the joint normal or nearly so (benign form). Or, on the contrary, when the swelling permits examination of the joint, very considerable changes may have already supervened; and these may go on rapidly to produce the most singular distortions, dislocations, or both, becoming manifest a few days after the first onset, as in the knees represented in Fig. 630, taken from Westphal.

Fig. 630.



Tabetic Arthropathy. (After Westphal.)

Besides dislocation, spontaneous fractures occur from the slightest force, such as turning in bed, or simply while walking along the ward. A singular characteristic is the almost complete immunity from pain, both at the dislocated joints and in the fractured bones. A patient described by Charcot, after an arthropathy had caused hip dislocation, used to walk some distance to her employment as a bed-maker. After a time the other hip was luxated; her legs were very movable but ill-controlled, and the joints flexible. So utterly painless were her limbs, that she used to amuse herself and the neighboring patients by floundering them about in bed. During one of these performances, the left femur was broken; some time after, while changing her position in bed, both bones of the left forearm were fractured; fifteen months afterwards the same accident occurred to the right forearm; and in the following month the left shoulder was dislocated by some very trivial movement. The fractures

The usual quick pulse of ataxia must not be mistaken for that of fever.

became united, apparently without difficulty, but in a most clumsy manner, the left radius and ulna being luted together by ill-formed callus. The left femur was so shortened that it was found, after death, to measure only 19 centimetres ($7\frac{1}{2}$ inches), while the right measured 50 centimetres ($19\frac{1}{2}$ inches).¹ The patient died, about a year or sixteen months after admission to the Hôtel Dieu, of ruptured aortic aneurism. In other cases, the bone after fracture has become very thin and twisted.²

The absence of pain in both dislocations and fractures is very important in a diagnostic point of view, as is also the peculiarly loose, mobile condition of the displaced bone—quite unlike any other luxation; for instance, in one of Dr. Buzzard's patients, it is said that "on removing the leather casing from the right knee, the joint seemed to fall abroad." The patient herself could replace the bones, and said that when she put on the casing she had to take the bones, put them straight in their places, and tie them together with a bandage, to keep them together while she put on the splint. The joint could be twisted about and the bones knocked together audibly without causing pain. Manipulation gave a feeling as of disappearance of all ligamentous connections, the bones seeming only held together by muscular and cutaneous tissues.³

Such a condition may well be believed to have existed in the knee and shoulder of a patient (represented in Fig. 631), who, for many years, was in the Salpêtrière, one of M. Charcot's favorite examples of this disease.

Fig. 631.



Tabetic arthropathy. (After Charcot.)

All the conditions of this disease, viz., presence of lightning pains, sudden advent, painlessness, extreme mobility, and absence of nodosities, mark it so distinctly from arthritis deformans, that it hardly appears desirable to contrast special points for differential diagnosis.

TREATMENT.—All that the surgeon can do for a disease depending, as this does, on a deep central lesion, is to retard the wearing away of bony surfaces

¹ This shortening appeared to be due to the friction of the two fragments causing atrophy of the upper one.

² Talamon, *Revue Mensuelle de Médecine*, 1878.

³ *Path. Trans.* vol. xxxi. p. 201.

by the friction of one part on another, and to obviate as far as possible dislocation and fracture. Both these objects can only be furthered by rest, more or less complete.¹ Light splints, bandaged on the limb, may be used for this purpose. The initial tumefaction may also be combated by judicious bandaging, but only lightly applied, lest more severe pressure should augment the tendency to bony absorption. Ball recommends a succession of blisters, but he gives no example of their benefit, and it is not easy to perceive what could be hoped from their application.

When dislocation has occurred, a case of leather, adapted to the deformed limb, should be applied. When fracture takes place, it must be treated on ordinary principles, the tendency to deformity being specially borne in mind. The whole local management must be subordinated to the condition and treatment of the neuropathy.

TUMORS OF JOINTS.

Tumors of joints are neoplasms originating in or upon the articular ends of bones.² The common connective tissues surrounding the joints may, like those tissues in other parts, be the site of tumors, but in point of fact they rarely are so affected; and any neoplasm so placed has no especial relation to the joint as a mechanism or organ. The tumors with which we have to do here are: (1) exostosis; (2) chondroma; (3) sarcoma; (4) carcinoma; (5) angioma; (6) aneurism of bone; and (7) echinococcus of bone. The three last are excessively rare.

Fibroid tumors, which are common enough about the bones inclosing the mouth and nares, where they are commonly called nasopharyngeal polypi, are very rare in the neighborhood of joints; while cystic tumors proper, infest almost exclusively the jaw-bones.

EXOSTOSIS is to be distinguished from hyperostosis, in that the former has a distinct and well-defined stalk from which the bulk of the tumor grows, but which itself does not increase. Hyperostosis has no defined or limited stalk, but is rather a conical, slightly elevated outgrowth from a broad, indefinite basis; its increase takes place, not by augmentation of the elevation, but of the base; it is, indeed, a local hypertrophy rather than a tumor, and resembles the thickening which results from chronic osteitis.

Exostoses are more especially accustomed to grow from the immediate neighborhood of epiphyseal junctions, and are therefore more common in youthful than in later life. Their favorite seats are: (1) The lower end of the femur; (2) the upper end of the tibia; (3) the upper end of the humerus, particularly from either edge of the bicipital groove. The exostoses that thus grow from limb-bones all belong to the cancellous variety—that is to say, their interior consists of cancellous or spongy bone, coated by an outer layer of more compact, but still soft, osseous tissue; and this is often covered by a layer of cartilage, which probably is the element of increase, ossifying on the attached, and growing on the free surface. Any portion of that surface which produces friction on superjacent structures, is very commonly covered by a bursa. In shape, exostoses assume two varieties; they are either smaller at their tip than at their base, and curved so as somewhat to resemble the spur of a cock—these are chiefly such as grow from or near

¹ See Weir Mitchell, *The Influence of Rest in Locomotor Ataxy*. *American Journal of the Medical Sciences*, 1873.

² False bodies within joints are not to be considered as tumors of joints.

to the attachment of a tendon—or they are mushroom-shaped, having a small cylindrical stalk, and a broad, outspreading end. These are such as in their growth project against the skin or tight fasciæ, or otherwise against firm obstacles.¹ Indeed, the shape of these growths depends chiefly or entirely on the pressure of surrounding parts. They are often multiple, several appearing on different bones, or on the same bone, and the tendency to these multiple exostoses is certainly hereditary. In 1879 my friend, Mr. Whitehead, now of the Army Medical Department, brought me a boy on whom we counted 238 exostoses scattered over every bone which could be felt. The boy's father, now no longer alive, had had, according to the lad's account, a great number of similar growths; and Mr. Whitehead took some pains to obtain an opportunity of examining the boy's brother, and told me that he had even more exostoses than the lad whom I saw.

One form of bunion consists of a mushroom-shaped exostosis, springing from the inner part of the first metatarsal bone, close to the phalangeal joint. It is doubtless produced in the first instance by wearing pointed shoes, forcing the great toe outwards, and causing excessive pressure to fall on the head of the metatarsal bone. Between the exostosis and the skin a bursa is developed, which frequently inflames, and sometimes suppurates. Exostoses are easily distinguished from all other growths by their form and situation; by their attachment to or union with the bone, following therefore its movements and being immovable independently; by their presence being unobserved until a certain size has been attained; and then by their slow growth.

These tumors very rarely produce trouble in the joint itself, but they frequently embarrass movement by pressing upon tendons and fasciæ, and thus interfering with their action.

Treatment.—No internal remedy, nor any outward application, affects the growth of an exostosis, and therefore the only remedy is detachment. Such an operation, however, could not be thought of for a moment in the case of multiple tumors; nor, indeed, does it appear to me desirable in single growths, unless pain on movement or very considerable deformity be produced. The removal is, as a rule, very easy.² A simple, longitudinal incision upon the most projecting point, or, if the growth be large, a semilunar cut, permitting a flap to be turned up, serves to expose the growth, whose base is then to be cleared with the scalpel or raspatory; a narrow saw, an osteotomy chisel, or cutting bone-forceps, may then be used to sever the base of the growth from its attachment. The section should be made so that no part of the stem is left attached, but the bone surface must be made level and smooth. If this have not been effected by the cutting instrument, the osteotrite or gouge must be used to make the part smooth and even. Great circumspection should be exercised in recommending this operation for the exostoses of bunions, especially in persons advanced in life.

The late Mr. Maunder, observing that in certain cases accidental fracture of an exostosis had relieved the patient from all pain and trouble, imitated this fortuitous occurrence in two cases.³ Protecting the skin by chamois leather, he seized the tumor in gas-fitters' pliers, and broke its stalk, afterwards using passive movement to prevent reattachment. In one case this attempt was unsuccessful (exostosis above outer femoral condyle), but the tumor became reunited in a position which hardly at all incommoded the patient. In the second case (exostosis on inner tuberosity of tibia) the growth remained loose.

¹ Exostoses which spring from the subscapular fossa and grow forward, are always thus flattened against the thorax.

² We have not now to do with ivory exostoses.

³ Clinical Society's Transactions, vol. xi. p. 59.

The method is worthy of consideration whenever the presence of a moderately thin stem is suspected.

CHONDROMA.—Closely allied to, perhaps an incomplete form of, the above, are the *enchondromata* that occasionally occur in youthful patients, about the edges of epiphyseal junctions; they are rare and unimportant, seldom attaining, unless by ossification they become exostoses, any inconvenient size. At page 454, a certain form of loose body in the joint is described as an *enchondrosis* growing from articular cartilage. More important are *enchondromata*. All cartilaginous tumors grow by preference from bones, yet occasionally they have been found in soft parts, as the mamma, or testicle. Enchondroma of bone may be in its origin either peripheral or central; the former variety is the more rare, and commences later in life, but sometimes it is not possible, even by anatomical examination, to distinguish between a peripheral tumor growing into the medullary canal and a central enchondroma growing outward. Clinically, they are absolutely indistinguishable; but the former is generally single, the latter multiple. A peripheral enchondroma commences in the fibrous layer of the periosteum, or in the more superficial layers of the bone; it both increases outwards, and, probably by pressure, invades likewise the osseous structure, penetrating into the medullary canal or cancellous structure. Central enchondroma commences in the medullary cavity, or cancellar portion, and after invading a certain district of those parts, causes absorption of the bone walls, and presents itself outwardly. Either form then appears as an irregularly round or ovoid tumor, nodular on its surface; sometimes remarkably so. It is sessile on the bone, but not so immovably as an exostosis, the elasticity of cartilage giving a sort of springy mobility, very different from the feel of a bony tumor; this quality also imparts to the lump, when pretty strongly compressed, a resiliency which the quite unyielding resistance of bone does not afford. When the tumor approaches the surface, and the skin is stretched tight over it, a slight translucency may aid the diagnosis. The favorite seats of enchondromata also assist their recognition; thus half the cases occur on the bones of the hand and foot, but five times as often on the former as on the latter; in either situation the tumors are multiple. The next seat of predilection is the tibia; nearly equal are the femur and humerus; the lower jaw and the pelvis stand next.

Although, as actual tumors, these growths may not make their appearance till at a later age, they probably begin at a very early period of life, their growth being slow. Every museum possesses at least one specimen of a hand crippled and deformed by a number of enchondromata growing from the phalanges or metacarpus, sometimes also from the ulna or radius. Enchondromata affect the joints by their proximity, but do not involve them in disease. Even in these cases of multiple growth, the joints, though the bulk of the neighboring tumors may affect their mobility, are left unaltered.

This neoplasm is often mixed with myxoma, sarcoma, or carcinoma; many also, which appear unmixed, are prone to mucoid and cystic degeneration; either circumstance gives greater gravity to the prognosis. Pure, undegenerated enchondroma is, as a very general rule, benignant, though instances of systemic infection have occurred. Recurrence *in loco* changes this characteristic, for such a condition is very apt to be followed by general infection.¹

¹ Recurrence must be carefully distinguished from mere continuance of growth in a part of the tumor not removed. The histology, diagnosis, and prognosis of tumors are treated in a part of this Encyclopædia especially devoted to the subject; here we have to do with them merely as they affect the joints. I have not included among tumors of joints the various false bodies described at page 453.

Those enchondromata which spring from the pelvis and scapula are, above all others, prone to recurrence and general dissemination.

*Osteoid chondromata*¹ are formed of tissue analogous to fibro-cartilage, not, as those just mentioned, of a hyaline variety. They have a special predilection for the ends of long bones, chiefly for the lower end of the femur or upper end of the tibia. From their seat of origin they encroach more and more on the shaft of the bone, while the older parts, growing likewise in circumference, are larger than the newer portions; they occupy not one side only, but the whole circumference of the bone. Thus, instead of forming, like simple enchondroma, a more or less round, nodulated lump, projecting on one aspect of the bone, they seem like a conical enlargement of the whole part, the thick end of the cone being always towards the joint, whose cartilage, however, remains intact; they are less hard than enchondromata, and are smooth on the surface.

At first, and while still small, they appear like mere hypertrophies of the bone itself; but they grow rather rapidly, and then become less hard than bone-substance, being at first within the periosteum, which forms their capsule or wall. Afterwards, that tissue is either absorbed and ruptured, after which the rate of growth increases, and the tumor, if left alone, goes on increasing as long as the patient lives, sometimes attaining an enormous size.² Very occasionally the tumor remains sufficiently soft to be cut with the knife, but it more usually ossifies pretty quickly. Sections of the softer parts have a fibrous appearance, but cartilage-cells, sometimes arranged in rows, may be detected with the microscope. Vessels permeate the structure, and the ossification is in needles and plates, so that, when the soft parts are removed by maceration, the bony parts left behind are somewhat similar to the architecture of a wasp's nest. The shell and tracing of the original bone may, as a rule, be found passing through the mass.

The *prognosis* of chondroma is not always favorable. The only *treatment*, amputation, should be performed above the bone from which the growth springs, and so that no part near the tumor forms the flap. Thus, exarticulation at the hip is necessary if the growth spring from the lower end of the femur; or in the lower third of the thigh if it arise from the tibia. Even under these circumstances, secondary growths sometimes occur in the lungs or liver.

SARCOMA AND CARCINOMA.—Sarcoma of bone has its favorite seat on the jaw. One form of epulis is well known as a giant-celled, or, as it is sometimes called, a myeloid sarcoma, a term which must not be taken as coincident with Paget's myeloid tumor.³ It had better be confessed at once that our knowledge of many sarcomatous tumors is as yet in a very unsatisfactory state, especially in regard to the malignancy or benignancy of different forms of growth. Nor does it at present appear that their anatomical characteristics correspond in any close manner with their clinical course. Indeed, one of the chief authorities on the histology of tumors reverts to naked-eye appearances:—

“We must mention one more peculiarity of sarcomata, namely, that they are sometimes so white, and at the same time so soft, as to have the greatest resemblance to brain-substance. These medullary (encephaloid) sarcomata possess the malignant qualities of sarcomata in the very highest degree; they may still have any of the histological structures previously referred to.”⁴

¹ Virchow, *Die krankhafte Geschwulste*, Bd. i. S. 597.

² Volkmann refers to a preparation in the museum at Halle, in which the tumor was almost a yard in diameter (fast eine Elle im Durchmesser). Pitha u. Billroth, *Chirurgie*, Bd. ii. Abth. 11, S. 461.

³ Lectures on Surgical Pathology, p. 544.

⁴ Billroth, *Lectures on Surgery*, Sydenham Society's Translation, vol. ii. p. 415.

As Prof. Billroth nowhere mentions cancer of bone, save to deny the existence of primary epithelioma of that structure, it would seem that he regards all malignant growths of bone as sarcomata; but a great number of excellent authorities—Virchow, Foerster, Volkmann, Paget, and others—speak of encephaloid cancer as springing from, or originating in, bone. My own observation leads me to the conclusion that many of these tumors are certainly carcinomatous, though most of those which are distinctly encapsuled must be regarded as sarcomata.

The ends of the long bones, and more especially the head of the tibia, the condyles of the femur, and the upper extremity of the humerus, are not very unfrequently the seat of sarcomata. They occasionally follow injury, after the method to which I last year gave the name of "acute traumatic malignancy,"¹ but more often appear to arise spontaneously, although even here the possibility of some apparently unimportant and probably forgotten injury must not be overlooked. They are affections of early life, rarely occurring after thirty years of age, and being most frequent between the fourteenth and the twentieth year, and occasionally arising even in infancy.² They mostly spring from the periosteum, but occasionally from the cancellous structure of the bone. Their microscopic characters, as in the above quotation Billroth has stated, may have any of the sarcomatous characteristics, but the most frequent varieties are the giant-celled, the round-celled, and the oat-celled (spindle-celled). The capsule which surrounds the structure is very thin in most parts, and in spots imperfect, probably having been absorbed or ruptured by the pressure of the rapidly growing mass.

The clinical appearances and symptoms of these growths are, when they have reached a considerable size, easy of recognition; but unfortunately, while they are still quite small, when diagnosis would be very important, it is also very difficult. The periosteal sarcoma begins, either after or without some traumatism, as a very slightly painful enlargement, and there will be a certain difficulty and restraint of movement, according to the situation, rather than the nature of the tumor. The tenderness is but slight, nor are there any inflammatory symptoms; the tumor itself is rounded or ovoid, rarely nodulated, and moves in flexion or extension with the bone, though if situated on a bone that can be rotated, it moves to a much slighter extent; it is, unless quite at first, soft and doughy. The patient's health as a rule is good, nor are any evidences of cachexia to be observed. These appearances, although obscure, should always arouse suspicion. An almost painless, non-inflammatory, ovoid tumor, sessile, but not rigidly so in the neighborhood of an epiphyseal junction, is of no good augury; no such growth should be allowed to remain unwatched.

The sarcoma which springs from the interior of a bone, often before any swelling is perceptible, gives rise to a dull, aching pain, analogous to and often mistaken for rheumatism; then some enlargement of the bone itself appears, and, in its turn, may be mistaken for ordinary osteitis, or for central abscess. After a little while, a great portion of the osseous walls being absorbed, only a thin shell is left, which very frequently crackles. Afterwards a certain portion of this bony cortex gives way, so that it may be traced on the side of the tumor, but the apex presents mere soft tissue. At this time it is impossible to distinguish between medullary sarcoma and soft cancer. These central, soft tumors of bone, when they have thus emerged outwards, very often pulsate, even though the growth itself may not be very

¹ British Medical Journal, February 11, 1882, p. 187.

² I amputated an arm at the shoulder-joint of a boy aged eleven, and I have twice seen malignant growth at the knee in young children; before the end of the first year in one, and at two years and three months in the other case.

vascular. The pulsation appears to depend on the increased size of the vessels which nourish the tumor; these, being confined in a non-yielding case, gain room for their pulse-throb by slightly extruding, at each beat, the tumor itself.¹ No periosteal sarcoma, as far as my experience goes, ever gives rise to pulsation. Thus the central may be distinguished from the periosteal sarcoma, by the presence of a shell of bone around the base of the growth, and usually by pulsation.

While still small, the diagnosis of sarcoma is doubtful, but the rapidity of its growth, and the development of certain appearances thereby produced, soon render its recognition easy. The tumor by this time is pyriform, with its larger end towards the joint, and usually with an even surface;² the skin over it is remarkably white and colorless, though late in the disease a blush is frequently perceived at those parts where the increase is greatest, and where the tumor presses on the skin. Over the white surface is spread a network of veins in close meshes, the blue coloring of the blood seen through the white skin giving a very striking and characteristic appearance. These tumors, though they run up to and even involve the neighborhood of the joint, so that its contour is concealed, do not implicate the joint itself, the cartilages on both bones remaining perfectly healthy. Thus the movements of the articulation are smooth, and only restricted by the contour of the growth coming in contact with parts of the adjoining limb-segment or of the trunk. The tumor feels soft, doughy, and hardly elastic; it moves in flexion and extension, and also follows the bone in rotation, but not to the full extent, especially if the tumor be periosteal; for the tissues of the neoplasm yield somewhat, so that the outer parts move less than those close to the bone.

Most sarcomata springing from the joint-ends of bones are malignant;³ they may be distinguished by their rapid growth, pyriform shape, and large surface-veins, from the few—very few—soft, non-malignant growths. Although sarcomata and carcinomata growing from the shafts of long bones not unfrequently undergo ossification (osteosarcoma and osteocancer), that change is rare in such as grow from the articular ends. Sundry other degenerations, however, take place, such as the cystoid, forming a sort of tumor that has been called myelo-cystic. If such a tumor have previously been very vascular, hemorrhage into one of these cysts may occur, and, the rent in the vessel remaining unsealed, an appearance which has probably been more than once taken for aneurism of bone, is produced. Or cystic, fatty, or mucous degeneration may, in great part, destroy the original structure of a very vascular sarcoma, leaving behind a plexus of enlarged vessels, and giving a deceptive appearance of aneurism by anastomosis of bone.

Other forms of cancer very rarely occur primarily in the long bones near joints; epithelioma probably always originates in the soft parts, and is propagated secondarily to the neighboring superficial bone. Both scirrhus and colloid cancer of bone are mere pathological curiosities;⁴ when they do occur, they are apt to affect many bones and to assume the diffuse form.

ANGEIOMATA OF BONE are excessively rare. The frontal, parietal, and occipital bones do indeed participate secondarily in cirroid aneurisms of the scalp

¹ The differential diagnosis between this disease and aneurism of bone will be given immediately.

² The surface in carcinoma is sometimes nodulated.

³ The central sarcomata of the jaws, more especially of the lower jaw, are rarely malignant; in my experience those of the limbs generally are so.

⁴ Some observers have spoken of colloid of the bones; but it is to be noted that with increased knowledge of the minute anatomy of tumors, such cases have become rarer, and in some instances a plentiful admixture of sarcomatous elements leaves room for doubting whether the growth is not in reality a mucoid degeneration of sarcoma.

which have persisted for years and attained certain dimensions, but this is a mere extension of disease along the course of affected vessels, a very different thing from primary angioma of bone.

ANEURISM OF BONE, that is, sacculated enlargement of a vessel within the osseous structure, gradually making its way outward, is extremely rare, and there is no doubt but that many of the older reported cases were instances of sarcoma that had undergone cystoid degeneration, a vessel enlarged by the hyperplasia having opened into one of the cysts. Nevertheless, real aneurism of bone does occur, and is a disease very difficult to be distinguished during life from some of the pulsating tumors which have been referred to. One point of difference is that in aneurism the tumor becomes more markedly smaller when pressure is made on the vessel above, and regains its former size much more rapidly. The pulsation is more distinctly expansile, not the up and down heave of a vascular sarcoma. Generally, aneurism of bone emits a very distinct, sometimes a loud, bruit, while if there be any sound connected with a pulsating sarcoma, it is a mere continuous murmur.

The favorite sites of osteo-aneurism are the head of the tibia, the condyles of the femur, and the head of the humerus. This disease, unlike the neoplasms which we have been considering, and which, as a very general rule, leave the articular cartilages intact, rapidly destroys those structures.

Treatment.—When there are grounds for believing that a pulsating tumor of bone is aneurismal, pressure, the use of an Esmarch's bandage, deligation, or other means mentioned in the article on Aneurism,¹ may be resorted to. Even if there be doubt as to diagnosis between a new growth and an aneurism, one of those methods may be advantageously employed before resorting to the severer means, amputation, which may still remain as a last resource, should further events negative the more hopeful diagnosis. In some cases, especially if the tumor lie deep, as in the iliac fossa, a positive diagnosis appears to be impossible.

ECHINOCOCCUS OF BONE.—An exceedingly rare tumor of bone is the hydatid or echinococcus, which, when it does occur, usually occupies either the bones of the skull or those of the vertebral column; but a few cases are on record of such parasites infesting the ends of long bones, and making their way into the neighboring joints, which by proliferation they have filled. The remarkably indolent tumor thus produced bears the strongest resemblance to true hyperostosis; indeed, the hydatid lying in the bone cannot be distinguished; the surgeon can only perceive the hypertrophy of bone which it sets up. After a time, the osseous case inclosing the cyst becomes, in some part of its superficies, absorbed, when this soft body may be felt, extremely like a simple cyst or an abscess, bound down by a firm wall.² As far as I know, no case of echinococcus of bone has ever been diagnosed, until by incision the cysts have been brought to light.

Whether by injection with iodine, carbolic acid, or chloride of zinc, the parent cyst may be successfully killed—that is to say, whether hydatids of bone may be successfully treated as we treat hydatids of the liver—has not yet been clinically determined; but the surgeon's duty would certainly be to make the attempt.

In regard to diseases of the joints, the subject of tumors is especially of interest in respect to diagnosis and prognosis. The tumors which most fre-

¹ See Vol. II. p. 862.

² Spontaneous fracture of bone has several times followed the development of echinococcus in its shaft.

quently occur—the bony, cartilaginous, sarcomatous, and carcinomatous growths—rarely affect the constituents proper of an articulation, save by extension of disease, and even then only tardily; the synovial membrane and the cartilages are not involved, but since the tumors lie close to or over the joint, and interfere with its movements, they clinically, and to the patient actually, present themselves as joint-diseases. The important points for him and for the practical surgeon to consider, are the probability of increase, with destruction of the joint, and with great incumbrance; the necessity or otherwise of removal of the tumor, or of the whole limb; the likelihood of recurrence *in loco*; and above all the probability of systemic infection.

EXCISIONS AND RESECTIONS.

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THE term EXCISION (from the Latin *ex*, out or from, and *cædo*, I cut), or EXSECTION (*ex* and *seco*, I cut), is properly applied to such operations as have for their object the removal of an offending part, without that total ablation of the affected portion of the body which is implied by the term *amputation*.¹ Hence, we speak of excisions of tumors, of joints, of the eyeball, etc. The term RESECTION (from the Latin *resecō*, I cut again, cut loose, or shorten by cutting, cut short), is properly used in a special and restricted sense, its etymological components being taken separately and in conjunction with omitted words, to signify an operation which takes away a middle portion and brings the ends together again, and is thus in strict surgical language limited to partial excisions of the long bones. Hence, while we *excise* the astragalus or scapula, we *resect* the humerus or ribs.² The revival of excision as a remedy for joint-diseases, chiefly due to the teaching and example of the great modern advocate of "conservative surgery," the late Sir William Ferguson, has caused this operation to attain such importance in the practical work of surgeons, that though the term "excision" is, as has been seen, applicable to a large number of diverse procedures, yet, when the word is used by itself, it is now understood to signify an operation for the removal, partial or complete, of an injured or diseased articulation, or of a bone, and generally one of the flat or short bones, which can be removed entire without jeopardizing the usefulness of the affected part.

HISTORY OF EXCISION AND RESECTION.

The operation of excision or resection, in cases of compound fracture and dislocation, was certainly known to the ancients. Whether or not we acknowledge the authenticity of the Hippocratic treatise, "*De Articulis*"—and, for my own part, I see no reason to profess skepticism in the face of evidence which has convinced such thorough scholars as M. Littré and Dr. Francis Adams³—there can be no doubt that long before the Christian era these operations were familiar to surgeons as a matter of theoretical teaching, even if they were not often put in practice. Having just declared that in cases of compound dislocation, except of the joints of the toes or fingers, attempts

¹ See Vol. I. p. 557.

² French writers use the word *résection* for excision of the bones and joints generally, and Percy and Laurent make a distinction between *résection* of the hard and *rescision* of the soft parts. (*Dictionnaire des Sciences Médicales*, tome xlvii. p. 538. Paris, 1820.)

³ The Genuine Works of Hippocrates (*Preliminary Discourse*), vol. i. pp. 24 *et seq.* London, Sydenham Society, 1849.

to retain the protruding bone would be improper, and would certainly prove fatal through the supervention of convulsions or gangrene, Hippocrates goes on to say, that not only may protruding articular extremities of the finger-bones, and protruding broken ends of the same (without dislocation), be safely cut away, in most cases, but "complete cuttings away, also, of the bones at the joints, both in the foot, and in the hand, and in the leg (those near the ankle), and in the forearm (those by the wrist)" will in most instances be harmless, unless fainting should occur, or continued fever on the fourth day.¹ In his treatise on compound fractures (in the continuity), he is still bolder in his recommendations, and declares that it is necessary to saw or file off the projecting bone if it cannot be reduced, if it irritate or lacerate the soft parts, or interfere with sensation, or if it be itself denuded.²

Celsus, while even more succinct than Hippocrates, would appear to make the rule more general; for, after quoting with approval the former author's cautions as to reducing compound dislocations, he adds briefly: "If the bare bone project, it will always be a hindrance; therefore what sticks out is to be cut off."³ He directs that, in dressing compound fractures, if a little fragment of bone protrudes, it is, if blunt, to be replaced; if sharp and long, to be cut off, and if sharp and short, filed off; and if denuded, to be cut off. He considers the reduction of fractured thighs particularly difficult, and says that if the fragments of the femur yield between themselves (overlap), it is almost necessary to cut them off.⁴

Galen declares that the teaching of Hippocrates is so plain and satisfactory as to need no comment, and merely adds that "modern physicians" call dislocations in which the bone protrudes "*εξυρρωματα*," and reminds the reader that the danger of the operation recommended, like that of the injury itself, increases with the magnitude of the joint affected.⁵ He throws no additional light upon the operation of resection as applied to compound fractures.⁶

Paulus Ægineta departs from the teaching of the Master in the matter of compound dislocations, which he advises should be, in every case, reduced; but approves resection in irreducible compound fractures, directing that the projecting fragments should be sawn off or cut off with an instrument which Dr. Adams speaks of as a "chisel," but which seems to me more analogous to cutting-forceps (literally, "antithetic through-cutters").⁷

The Arabian writers add nothing to our knowledge of this subject, Albucasis,⁸ who is the only one who deals with the matter in detail, giving advice almost identical with that of Paulus Ægineta: "Cut it off," he says, "with one kind of the cutting instruments which we have spoken of, or saw it with one of the saws, as may be possible to you." Haller,⁹ however, in his analysis of Rhazes's "*Liber Continens*," quotes from that author a statement that if the bone be corrupted [carious] in "*spina ventosa*," a cure cannot be obtained unless the bone be extracted. I have not had the opportunity to consult Rhazes's work, but from Haller's brief reference this looks very much like a recommendation of *excision for disease*.

The advice of Hippocrates, that resection should be practised in cases of

¹ Hippocratis opera omnia, edit. cur. C. G. Kuhn, t. iii. p. 246. Lipsiæ, 1827.

² Ibid., p. 121.

³ A. C. Celsi Medicinæ lib. viii. cap. xxv. Edit. L. Targæ, p. 471. Lugd.-Bat., 1785.

⁴ Ibid., pp. 452-454. This passage might also be rendered to the effect that in such a case the patient would almost necessarily perish.

⁵ Claudii Galeni opera omnia, edit. cur. C. G. Kuhn, t. xviii. pars i. p. 714. Lipsiæ, 1829.

⁶ Ibid., t. xviii. pars ii. p. 603.

⁷ Pauli Æginetæ Medici Optimi lib. vi. cap. cvii., cxxi. Editio princeps. Venetiis, in ædibus Aldi, etc., fol. 100, 104.

⁸ De Chirurgia, lib. iii. sect. xix. Edit. cur. J. Channing, Oxon., 1778, t. ii. p. 589.

⁹ Bibliotheca Chirurgica, t. i. p. 130. Basileæ, 1774.

compound fracture in which the bone protruded from the soft parts, appears to have been occasionally remembered and acted upon in subsequent ages, while his similar recommendation as regarded compound dislocations, was quite forgotten. Thus Salmon,¹ speaking "of a fracture with a wound, the bone sticking out," says, "But if this Reposition cannot be easily done, or not without pain and violence, then of two evils, the lesser is indeed to be chosen; and therefore that the Reduction may be made, the end of the longer bone is to be cut off with a cutting File, or with a sharp, fine saw, or some other Instrument, that it may be made a little shorter;" but in his account of dislocations,² has no further suggestion, "when the Joint or Bone cannot be reduced," than that the part should be comfortably supported, and care taken "for Universals and Diet." Wiseman, too,³ speaks of resection in compound fractures, and narrates a case in which he successfully employed the operation, but makes no reference to it in connection with the treatment of dislocations.

The first record which we have, in modern times, of an excision for *compound dislocation*, is Mr. Gooch's statement,⁴ that, "many years ago," Mr. Cooper, late of Bungay, sawed off the ends of the tibia and fibula, instead of amputating, in a case of compound luxation of the ankle in an elderly man, with the happy result that the preserved limb was so useful "that the poor man walked and wrought for his bread many years after." Mr. Cooper was afterwards equally successful in a compound dislocation of the wrist, in which the radius protruded, and Mr. Gooch himself successfully employed a similar operation in the treatment of a compound dislocation of the thumb. Mr. Wainman, of Shripton, successfully excised the lower part of the humerus for compound luxation of the elbow, in 1759,⁵ while on August 23, 1762, Mr. Filkin, of Norwich, performed the first recorded *excision for disease*, in a case of long standing caries of the knee.⁶

To Mr. Park himself belongs the credit of having first formally recommended excision as a substitute for amputation in cases of incurable arthritis, or, as it was commonly called, "white swelling," though he was anticipated in the actual performance of the operation by Filkin, of Norwich, as above mentioned, in the case of the knee; by Bent,⁷ of New Castle, and Lentin⁸ (1771), and Orred,⁹ of Chester (1778), in the case of the shoulder; and by Justamond,¹⁰ of London (1775), in the case of the elbow.¹¹ Park's first operation was performed on July 2, 1781, on Hector McCaghen, "a strong, robust, Scotch sailor, aged thirty-three," who was suffering from disease of the knee-joint of ten years' standing. The operation resulted so successfully that the

¹ *Ars Chirurgica*, Book vi. chap. viii. (vol. ii. p. 1222). London, 1698.

² *Ibid.*, Book vii. chap. iv. (p. 1303).

³ *Eight Chirurgical Treatises*, sixth edition, vol. ii. pp. 258, 259. London, 1734.

⁴ *Cases and Practical Remarks in Surgery*, etc., second edition, vol. ii. p. 323. Norwich, 1767.

⁵ Park's letter to Mr. Percival Pott. *Cases of the Excision of Carious Joints*, by H. Park and P. F. Moreau, with Observations by James Jeffray, M.D., p. 10. Glasgow, 1806. Mr. Park's letter is dated September 18, 1782, and he says that Mr. Wainman's operation was done "twenty-three years ago."

⁶ Park's letter to Dr. Simmons. *Ibid.* pp. 52-55.

⁷ *Philosophical Transactions* (London), vol. lxiv. p. 353. (Hodges.)

⁸ O. Heyfelder, *Traité des Resections*, trad. par le Dr. E. Boeckel, p. 163. Strasbourg et Paris, 1863.

⁹ *Philosophical Transactions* (London), vol. lxix. p. 6. (Hodges.)

¹⁰ *London Medical Journal*, vol. iv. p. 282; Park, *op. cit.*, p. 55.

¹¹ All of the above (except Filkin's) seem to have been partial operations. C. White's case (1768), usually regarded as the first example of shoulder-joint excision, appears to have been actually a resection in the shaft of the bone, the caput humeri having been allowed to remain attached to the glenoid cavity, and the same may be said of the similar operation performed by Vigaroux, of Montpellier. See upon this point Dr. R. M. Hodges's well-known and admirable prize-essay on the *Excision of Joints*, Boston, 1861 (page 22).

patient "afterwards made several voyages to sea, in which he was able to go aloft with considerable agility, and to perform all the duties of a seaman," and "was twice shipwrecked, and suffered great hardships, without feeling any further complaint in that limb."¹ Mr. Park's second case (1789) terminated less favorably, the patient dying between three and four months after the operation.²

Meanwhile, in France, the elder Moreau had independently conceived the idea of removing carious bones and joints by an operation less mutilating than amputation, and in August, 1782, had put his ideas in practice by cutting out "a caries of considerable extent, from the lower end of the leg bones of a man called Lecheppes."³ The operation was completely successful, and in the following year (1783) M. Moreau laid his views before the Academy of Surgery,⁴ definitely proposing the operation of complete excision of diseased articulations. In 1786, the same surgeon communicated to the Academy the history of a case in which he had in that year successfully removed the whole shoulder-joint for disease—the first recorded case of complete shoulder-joint excision—but neither of these communications seems to have excited enough interest to have been thought worthy of publication. A third memoir, presented in 1789, met with almost universal disapproval and condemnation, the learned members of the Academy, as the younger Moreau tells us, finding it more convenient to deny, than to examine, the facts on which it was grounded;⁵ and except for the operations in military practice of the illustrious Percy, and certain isolated cases in the hands of the two Moreaus, the father's pupil, Someillier, and a few others, the practice of excising diseased joints met with so little favor in France that even Velpeau, writing in 1839, though deciding that, "upon the whole, the mass of the advantages of resection [excision]" was "more considerable than that of its inconveniences," yet averred that, as compared with amputation, the balance was so nearly even, that it might "well be permitted to hesitate before absolutely sanctioning its utility."⁶

In Great Britain, too, the operation was very slow in making its way into general surgical practice, the actual establishment of excision as a recognized procedure, when applied to the shoulder and elbow-joints, being fairly attributable to Mr. Syme, of Edinburgh, in the years 1826 and 1828 respectively; as regards the hip, knee, and wrist-joints, to Sir William Fergusson, in 1845, 1850, and 1851 respectively; and as regards the ankle-joint, to Mr. Hancock, also in 1851.

Among the earliest American advocates of this operation may be particularly mentioned Drs. Ingalls, John C. Warren, and Henry J. Bigelow, of Boston; Drs. Gurdon Buck and Lewis A. Sayre, of New York; Drs. Thomas Harris and Joseph Pancoast, of Philadelphia; Dr. R. A. Kinloch, of Charleston; and Dr. Edmund Andrews, of Chicago.

I do not intend to review here the controversies as to the propriety, particularly of hip-joint and knee-joint excisions, which raged within the memory of the present generation of surgeons both in England and in this country. The conflict is yet too recent, the smoke of battle too thick, for the history of those controversies to be written without risk of giving unmeant offence, if not of doing unintentional injustice. The victory has been won by the friends

¹ Op. cit., pp. 18, 47.

² Park and Moreau, op. cit., p. 81.

³ Mr. Park's case was not known in France till the next year (1784), when his observations were translated and published in that country by the celebrated Lassus.

⁴ Park and Moreau, op. cit., p. 84.

⁵ Nouveaux Éléments de Médecine Opératoire, 2e édition, t. ii. pp. 681, 682.

⁶ Op. cit., pp. 48-52.

of "conservative surgery," and it becomes those who have conquered to wear their laurels with modesty as well as with dignity.

INDICATIONS FOR AND CONTRA-INDICATIONS TO THE OPERATION OF EXCISION IN GENERAL.

Excisions of *joints* may be practised in cases of *wound*, whether by accidents of civil life or by gunshot injury; of *compound dislocation* or of *compound fracture* involving a joint; of *destructive disease of an articulation*; and of *anchylosis*.

Excisions or resections of *bones* may be required in cases of *compound fracture*; *compound*, or *irreducible, simple dislocation* (in the case of some of the short bones, such as the astragalus); *ununited fracture*; *deformity* following fracture or other injury; and *disease*, whether *inflammatory* or *neoplastic*.

WOUNDS OF JOINTS.—The applicability of the operation of excision to joint-wounds has been so fully considered in previous portions of this work,¹ that I need not dwell upon the subject here further than to say that, in my judgment, when any operation at all is required, the surgeon's first thought should be of excision, rather than of amputation. Even in the case of the knee, though excision for traumatic causes is less favorable here than in any other locality, I should be strongly tempted to give this mode of treatment a trial if the patient were young and healthy, and if the injury were sufficiently limited in extent.

COMPOUND DISLOCATIONS.—I am disposed to agree with Hippocrates and Celsus that, in cases of compound dislocation, immediate excision should, as a rule, be practised, except when the part involved is the knee, when amputation will ordinarily be preferable. I have, however, myself saved a case of compound dislocation of the ankle, without operation, by the use of continuous irrigation, and similar successes are occasionally met with by almost all surgeons. The great advantage of excision in these cases lies in its preventing the destructive inflammatory tension which is almost inevitable when simple reduction has been effected.

COMPOUND FRACTURES INTO JOINTS are also, as a rule, cases for excision (provided that amputation be not required), and for the same reason, viz., the avoidance of injurious tension from the inevitable swelling, and from retention of the products of inflammation. When the knee is the part affected, amputation should, I believe, be resorted to without hesitation; but in the case of the joints of the upper extremity, and of the hip and ankle, I should prefer excision whenever a choice of operations was admissible.

With regard to the *period of operation*, in cases of compound fracture, the same rules may be given as for amputation under similar circumstances, viz., that *primary* excision should be preferred, but that if the golden opportunity of operating before the onset of inflammatory fever has been lost, an effort should be made to temporize until suppuration has been fully established, when a *secondary* excision may be resorted to with more prospect of success than would have attended an *intermediate* operation. This will appear from the following table of determined cases in military surgery, compiled from the

¹ By Prof. Andrews on page 354 *et seq.* (*supra*), and, as regards gunshot wounds in particular by Prof. Conner, in Vol. II. pp. 155 *et seq.*

figures of Gurlt,¹ and supplemented, as regards the hip and the knee, by those more recently published by Drs. Otis and Huntington.²

TABLE SHOWING THE INFLUENCE OF THE PERIOD OF OPERATION ON THE RESULTS OF EXCISIONS OF THE LARGER JOINTS.

Locality of operation.	PERIOD OF OPERATION.								
	Primary.			Intermediate.			Secondary.		
	Cases.	Deaths.	Mortality per cent.	Cases.	Deaths.	Mortality per cent.	Cases.	Deaths.	Mortality per cent.
Shoulder	556	177	31.8	128	68	53.1	614	241	39.3
Elbow	389	84	21.6	113	33	29.2	681	194	28.5
Wrist	39	4	10.3	8	3	37.5	53	12	22.6
Hip	43	40	93.0	60	58	96.7	37	23	62.2
Knee	37	23	62.2	53	46	86.8	31	20	64.5
Ankle . . . . .	...	...	.....	7	3	42.9	123	44	35.8
Aggregates . .	1064	328	30.8	369	211	57.2	1539	534	34.7

Locality of operation.	Late Secondary.			Unknown.			Totals.		
	Cases.	Deaths.	Mortality per cent.	Cases.	Deaths.	Mortality per cent.	Cases.	Deaths.	Mortality per cent.
Shoulder	27	1	3.7	111	21	18.9	1436	508	35.4
Elbow	14	...	.....	112	11	9.8	1309	322	24.6
Wrist	7	...	.....	12	...	.....	119	19	16.0
Hip	4	3	75.0	27	24	88.9	171	148	86.5
Knee	2	2	100.0	8	5	62.5	131	96	73.3
Ankle	1	...	.....	2	1	50.0	133	48	36.1
Aggregates . .	55	6	10.9	272	62	22.8	3299	1141	34.6

It will be seen from the preceding table, that the only exception to the rule that primary excisions are the most successful, is in the case of the hip, where secondary excisions gave the best result. But this by no means proves that primary operations should be avoided in these cases. The patients who survive until the secondary period furnish, by the very fact of survival, selected cases which offer an exceptionally favorable prognosis. I have no doubt of the entire correctness of the opinion expressed by Dr. Otis and Dr. Huntington, that "The disastrous results attending cases of indubitable shot-fracture at the hip treated by temporization [a mortality rate of 98.8 per cent.] must induce the surgeon to desist from such an experiment, and to excise primarily rather than submit the patient to the danger of the inflammatory period."³

The table embraces no example of *primary excision of the ankle*, but that the primary period is the best for interference in cases of wound of this as of other articulations, is shown by the results of 33 cases tabulated by Dr. Otis and Dr. Huntington from the records of the American War.⁴

¹ Die Gelenk-resectionen nach Schussverletzungen, u. s. w. Berlin, 1879. See an able analytical review of Prof. Gurlt's work, by Dr. G. M. Kober, U. S. A., in the American Journal of the Medical Sciences, for April, 1881.

² Medical and Surgical History of the War of the Rebellion, Part Third, Surgical Volume. Washington, 1883.

³ Op. cit. Part Third, Surgical Volume, page 126.

⁴ Ibid. page 585.

Period of operation.	Cases.	Recoveries.	Deaths.	Undetermined.	Mortality per cent. of determined cases.
Primary	11	8	2	1	20.0
Intermediate	8	5	3	...	37.5
Secondary	9	5	4	...	44.4
Unknown.	5	4	...	1	..
Aggregates	33	22	9	2	29.0

JOINT DISEASE.—It is, however, in cases of destructive disease of the articulations, whether of traumatic or of non-traumatic origin, and whether of simple, inflammatory, or of scrofulous or tuberculous character, that the operation of excision finds its principal application. The indications and contra-indications which the surgeon should consider before deciding upon the propriety of excising a diseased joint, may be briefly stated as follows:—

Excision is indicated (1) when an articulation is so much diseased that the recovery of the patient depends upon its removal; under such circumstances, the question is between excision and amputation, and the former operation should certainly be chosen whenever the circumstances of the particular case permit an option. In saying this I am not unmindful that a few surgeons may still be met with, who profess to believe that a stump with an artificial limb is better than a limb of flesh and blood; but these will, I think, be generally found to be gentlemen who have had little, if any, practical experience with the operation which they condemn.

(2) Excision is occasionally proper in cases in which, while the extent of disease is not sufficient to justify an amputation, the *length of time* which would be necessary for the obtaining of a spontaneous cure would be such as of itself to warrant operative interference, or in which the result of a spontaneous cure, if obtained, would be less satisfactory as regards the usefulness of the limb than the result of an operation. In the elbow, for instance, the movable joint afforded by a successful excision, is much preferable to the cure by ankylosis, which is commonly the best that can be hoped for by expectant treatment.

Excision is, on the other hand, contra-indicated (1) by the extent of osseous disease being so great that its entire removal would forbid the hope of retaining a useful member, under which circumstances amputation would be preferable. This rule is particularly applicable in the case of articulations of the lower extremity; as regards the arm, provided that the hand be preserved, the bones may be more freely dealt with, and large portions may often be removed without materially impairing the utility of the limb.

(2) Excision is not ordinarily applicable to cases of *acute disease* of the articulations. If it be necessary to interfere at once, under such circumstances, experience shows that an amputation is more apt to be well borne than an excision; an attempt should always be made, however, if the general condition of the patient permit it, to modify the acute course of the disease by appropriate treatment, both constitutional and local, when, if the severity of the symptoms be subdued, and the case assume a subacute or chronic character, excision may be properly resorted to.

(3) Very extensive *disease of the soft tissues* around a joint, and particularly the existence of peri-articular abscesses, and of long, suppurating sinuses, passing up and down between the muscular sheaths of the limb, undoubtedly

exercise a prejudicial influence upon the progress of a case after excision, by prolonging the time required for treatment, and by thus exposing the patient to the various risks which always attend long-continued suppuration. But such a state of affairs cannot be said to absolutely contra-indicate the operation, and, if the other features of the case be favorable, excision may often be hopefully resorted to, even if the tissues be much infiltrated and the skin fairly riddled with sinuses. I have more than once excised the hip, under such circumstances, with the happiest result.

(4) Excision is contra-indicated in cases in which the patient is either *very young* or *past early middle age*. Children less than five years old are unfavorable subjects for excision, at least of the joints of the lower extremity, on account of their intolerance of the restraint necessary in the after-treatment of these cases; and indeed, as regards excision of the knee, I have in recent years been disposed to fix this limit at a still later period, and I am now chary of attempting a knee-joint excision in a child under nine or ten. On the other hand, the mortality which follows the operation of excision, as we shall see presently, rapidly increases with advancing age—more rapidly, even, than the mortality after amputation; and hence, though brilliant successes have occasionally been obtained by excision in old persons, these results must be considered exceptional, and the prudent surgeon will usually prefer amputation—if any operation be necessary—in patients who have passed the middle period of life. The objection which is often urged against excision in childhood, that it interferes with the future growth of the limb, is more apparent than real. Bæckel, of Strasbourg, from an investigation of more than twenty cases of arrested development, came to the conclusion that the shortening was less due to injury of the epiphyseal cartilages than to disuse of the limb owing to pain or to muscular atrophy; and, as shown by Mr. Barwell at page 473 of the present volume, the arrest of epiphyseal growth is by no means unlikely to occur as a result of inflammation, even in cases treated without operation.

In illustration of this point, I may refer to a case in which I excised the knee of a lady, 30 years of age, sent to me by Dr. Massey, of West Chester; the disease of the joint had begun when she was only seven years old, so that it was of 23 years' standing when she came under my care. The knee was flexed beyond the right angle, and the whole limb, below the knee, very much wasted, and by actual measurement four inches shorter than its fellow. She walked, with great difficulty, by the aid of a crutch or cane, and high-soled shoe, the shortening being so much increased by the flexion of the limb that a sole of seven inches merely enabled her to bring her toes to the ground. By the operation of excision, I was enabled to give this lady a strong and straight limb, and, as with exercise the muscles of the leg became developed, and the ankle strengthened, she was enabled to throw aside her artificial supports; and though a considerable amount of bone had of course been removed at the operation, she was, by the straightening of her limb, now able to walk easily and without fatigue, with a sole of but five inches' thickness, her leg being thus practically two inches longer than it had been before the excision. I have recently heard from Dr. Massey that this lady now—more than six years since the operation—continues in excellent health, and walks without any artificial support whatever.

(5) An impaired state of the general health, particularly if this condition be due to organic disease of the viscera—and especially of the lungs, liver, or kidneys—should always be regarded as a contra-indication to excision. The operation, at least in the lower extremity, usually necessitates long confinement of the patient during the after-treatment, and is apt to be followed by profuse and exhausting suppuration, thus seriously compromising the chances of recovery. Hence, as a rule, if any operation becomes necessary in a case

of joint disease complicated with phthisis, Bright's disease, or amyloid degeneration, amputation will offer the patient a better chance than excision.

ANCHYLOSIS.—It often happens that while *incomplete* or *fibrous ankylosis* has occurred in one portion of a joint, destructive disorganization is progressing at another, and under such circumstances excision may of course be required, as in cases of destructive disease without any attempt at repair. There are, too, cases of fibrous ankylosis, with the limb in a bad position, and complicated by frequently recurring attacks of arthritis, in which excision will prove the best remedy. Such a case was that illustrated by Figs. 689, 690 (page 624), in which I excised the knee many years ago, at the Episcopal Hospital. *Bony* or *complete* ankylosis is usually amenable to milder remedies than excision—subcutaneous osteotomy, as practised by Mr. Adams and Mr. Maunder, or drilling, after the manner recommended by the late Dr. Brainard, of Chicago, commonly proving satisfactory. In some cases of bony ankylosis of the knee, however, a better result may be secured by Gurdon Buck's method of sawing out a wedge-shaped portion embracing the whole thickness of the bone, and containing the femoral condyles, head of the tibia, and patella—what has since been called excision in a block—and in the case of the elbow, excision will prove the best mode of treatment, as permitting recovery with a movable joint, which could hardly be obtained in any other way.

COMPOUND FRACTURES OF THE LONG BONES may occasionally require a resort to resection, either to facilitate reduction, when a fragment protrudes through the wound and cannot be replaced, or when, though the bone is much shattered and comminuted (as by gunshot injury), the destruction of parts is not so great as to necessitate amputation. Except in military practice, however, the operation is seldom required in these cases, it being usually better simply to remove loose fragments and trust the rest to nature; nor does my own experience lead me to recommend resection of the long bones, even in cases of gunshot wound, except in the forearm, when only one of the two bones is injured, and, perhaps, in the fibula. I have with advantage resected the lower jaw, in a case of gunshot injury attended with great splintering and comminution.

DISLOCATIONS OF THE BONES OF THE FOOT may require excision of the displaced bone, if the injury be compound, or if, though simple, the bone be irreducible and so placed as to interfere with locomotion. The astragalus is the part which most often requires removal under these circumstances, but the question of operation may also arise in the case of the bones of the anterior tarsus.

UNUNITED FRACTURE not unfrequently calls for the operation of resection, which indeed, when performed in the manner recommended by Prof. Ollier and Prof. Bigelow—preserving the periosteum and fastening together the freshened ends of the fragments with a wire suture—constitutes the most certain remedy for this condition, and is one that I have repeatedly resorted to with complete success.

DEFORMITY resulting from badly treated fracture or other injury of a bone may be a cause for resection.

A few years ago, I had under my care, at the University Hospital, a man who as a consequence of fracture of the fibula and contusion of the tibia, followed by osteitis,

presented so marked an outward flexion of the lower third of the leg as to seriously interfere with walking. By cutting away a wedge-shaped segment of the tibia, and a small disk of the fibula, I was enabled to bring the bones into good position, and then fastening them with sutures of thick silver wire and placing the limb in a bracketed splint, such as will be hereafter described in connection with excisions of the ankle, I succeeded in obtaining firm union without any reproduction of the deformity, and gave the patient a perfectly useful, though slightly shortened member.

Excision of the astragalus or other tarsal bones has been successfully practised to relieve the deformity of inveterate cases of *club-foot*.

CARIES AND NECROSIS.—Many cases which are described as excisions of the long bones for *necrosis* are in reality nothing more than sequestrotomies, and, indeed, it is hard to conceive of an ordinary case of slow necrosis in which formal excision could be justified; if uncomplicated, the sequestrum should certainly be removed without unnecessary disturbance of the new-formed involucrum, and if this were forbidden by implication of the neighboring joints or other circumstances, amputation would probably be indicated. There are, however, cases of *acute necrosis*, resulting from subperiosteal abscess, in which immediate interference is necessary, and in which removal of the entire shaft of the bone, after splitting the periosteum longitudinally, may permit the preservation of the limb. Brilliant and successful operations of this kind have been recorded by Mr. T. Holmes, Dr. Shrady, and other surgeons.

Caries is usually amenable to milder treatment than removal of the entire bone, but in cases in which the disease is too extensive for gouging, or for Prof. Sédillot's method of *évidement*, subperiosteal excision may be properly resorted to.

RACHITIC DEFORMITIES of the long bones have occasionally been thought to justify resection, but in almost all cases can be remedied either by the use of mechanical appliances or by the less dangerous operation of subcutaneous osteotomy.

TUMORS OF BONES, finally, may become the indication for excision. In the case of the long bones amputation should usually be preferred, though successful resections for myeloid growths of the radius and ulna have been recorded by Mr. Lucas and Mr. Morris. In the case, however, of the round or flat bones—as, for instance, the maxillæ, scapula, or clavicle—excision may properly be performed.

The remarks which have already been made as to the indications and contraindications of excision, in cases of joint-disease, are equally applicable, *mutatis mutandis*, in regard to resection for injuries and diseases of the bones. From them it will be perceived that, while these operations are, in suitable cases, admirable and truly conservative procedures, they are yet, after all, adapted only to selected cases; it is therefore manifestly unfair to attempt, as is sometimes done, to prove that excision is a less grave operation than amputation, by instituting a comparison of their statistical results; the fact being that while the first-named operation is habitually reserved for the more favorable cases, the other is, of necessity, employed for those which offer a less favorable prognosis. Greatly as I admire the operation of excision, and strongly as I deprecate, under all circumstances, the unnecessary sacrifice of a limb, I cannot but believe that, other things being equal, excision is, in most regions of the body, at least as fatal, if not more fatal, than the corresponding amputation.

PROCESS OF REPAIR AFTER EXCISION.

In studying the process by which repair is effected after excision or resection, we must refer for a moment to the means by which the growth of the bones is accomplished in a state of health. Bones increase in *thickness* by proliferation from the inner layer of their periosteal covering, and in *length* through the medium of the epiphyseal cartilages, or, as Ollier has called them, the cartilages of conjunction. Hence, in resections of the shafts of the long bones, it is important to preserve the periosteum, and when this is done, as it can be in cases of acute necrosis, complete reproduction may be effected, although immediately after the operation the limb may have appeared quite limp and boneless. So, too, in operations on the short bones, when the operation can be made subperiosteal, the restoration of the part is much more complete and satisfactory than under other circumstances.

Another great advantage which attends subperiosteal excision in all situations, is that it permits the affected bone to be removed without disturbing the attachments of the various muscles, a matter which is, of itself, of very considerable importance.

In excisions of the joints in young persons, care should be taken not to infringe upon the line of epiphyseal junction, since, if the entire epiphysis be removed, the growth of the limb will be materially interfered with. The annexed wood-cut (Fig. 632), from a patient under my care some years since at the Episcopal Hospital, shows what great deformity may result from epiphyseal injury in childhood. No operation had been performed in this case, but it serves to illustrate the importance of the epiphyses in maintaining the growth of the limb.

Ollier has pointed out the interesting fact that tumors of the long bones find their favorite seats at that extremity from which the principal growth of the bone proceeds, and has shown the dependence of both events upon the particular direction of the nutritious artery. Thus, the humerus grows mainly from its upper epiphysis, and the bones of the forearm from the epiphyses near the wrist, while in the lower extremity the growth of both leg and thigh is chiefly effected by the epiphyses in proximity to the knee. Hence the risk of hindered growth after excision is comparatively slight at the elbow, hip, and ankle, and is most to be dreaded in operations at the shoulder and wrist, and, above all, at the knee, since shortening is of much greater consequence in the lower than in the upper extremity. On the other hand, since at the knee firm, bony union is sought for, it is less important to preserve the periosteum in excisions of this joint than in those of the other articulations, where it is wished to preserve the power of motion, and where, therefore, a more or less perfect reproduction of the articulating extremities is hoped for.

Fig. 632.



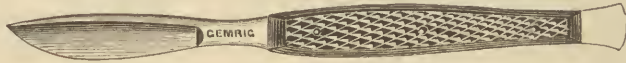
Deformity from injury of radial epiphysis.

Repair after excision of the knee, or after any other excision which is followed by bony union, and repair after resection in the continuity of the long bones, is effected in the same manner as repair after compound fracture. The sawn ends of the bones undergo a retrograde metamorphosis into granulation-tissue, and the granulations from the approximated surfaces coalescing, osseous matter is again deposited, and in time complete synostosis results. In the case of the shoulder, hip, or elbow, though, in some few instances, a new capsule, and even a new synovial membrane, seem to have been formed, in the immense majority of cases union of the resected bone-ends is effected through the medium of strong cicatricial bands, analogous to those met with in fibrous ankylosis. A similar substance fills the gap after excisions of the short bones, such as the calcaneum and astragalus (when the operation is not done subperiosteally), and it is surprising to see, in these cases, what a firm mass fills the place of the excised bone, and how little deformity, in many instances, results.

OPERATION OF EXCISION IN GENERAL.

INSTRUMENTS EMPLOYED IN EXCISION.—The *knives* required for excisions are strong scalpels and bistouries; a good form for the first-named instrument is that shown in Fig. 633, the handle being armed with a steel raspatory, which

Fig. 633.



Strong scalpel with raspatory, for excisions.

is convenient for separating the periosteum. Another very useful knife is that shown in Fig. 634, with a probe-point, very heavy back, and limited

Fig. 634.



Erichsen's probe-pointed knife with limited cutting edge, for excisions.

cutting edge; it can be used freely in the deep parts of the wound without risk of wounding large vessels or other important structures, an accident

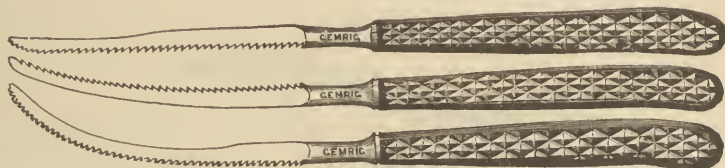
Fig. 635.



Chain-saw.

which has occurred (through using sharp-pointed knives) in the hands of very eminent operators, and which may cause loss of the limb, if not of the patient's life. The most useful forms of *saw* are that known by the name of Mr. Butcher,¹ and the chain-saw (Fig. 635), the merit of introducing which is divided between Dr. Jeffray, of Glasgow, and Dr. Aiken, of Edinburgh;² small but thick-bladed saws, such as are shown in Fig. 636, are also useful in some cases. *Bone-forceps*, of various sizes and shapes, will be required, the

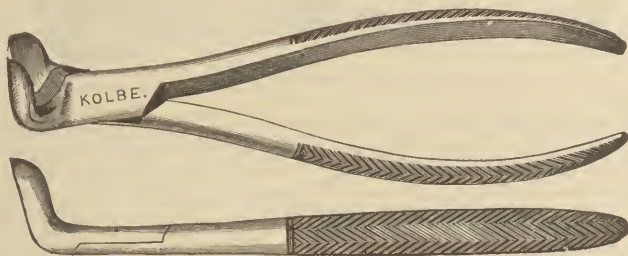
Fig. 636.



Small saws for excisions and resections.

most important being the strong-cutting pliers of Liston,³ and the lion-jawed forceps of Ferguson.⁴ The angular (Fig. 637) are sometimes more convenient

Fig. 637.



Angular cutting forceps.

than the straight Liston's forceps, and for certain operations about the jaws the instrument shown in Fig. 638 will be found of value. Butcher's knife-

Fig. 638.



Cutting forceps for operations on the jaws.

bladed forceps (Fig. 639), are particularly useful for cutting away the thickened synovial membrane in excisions for gelatinous arthritis of the knee and

Fig. 639.



Litcher's knife-bladed forceps.

¹ See Vol. I. p. 579, Fig. 127.³ See Vol. I. p. 579, Fig. 128.² Park and Moreau, op. cit., p. 175.⁴ See Vol. I. p. 579, Fig. 129.

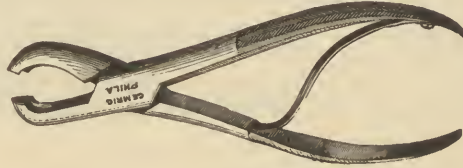
elbow. Should caries extend to a point beyond that at which it is thought prudent to apply the saw, it may be dealt with by means of the *gouge* (Fig. 640), or *gouge-forceps* (Fig. 641), or the *osteotrite* or burr-head rasp (Fig. 642).

Fig. 640.



Bone-gouge.

Fig. 641.



Gouge-forceps.

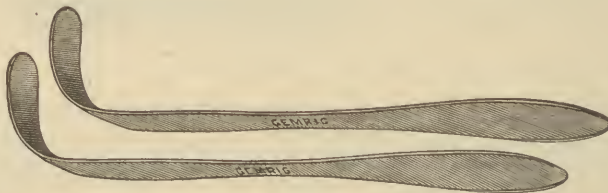
Fig. 642.



Osteotrite or burr-head rasp.

Other instruments which should be at hand are a pair of *retractors* (Fig. 643), for protecting the soft parts and facilitating the exposure of the bone, a *periosteal elevator* (Fig. 644), and, if an ordinary saw be used, a *resection-sound*,¹ Dr. Prince's probe-pointed grooved retractor, or, which in some cases will answer

Fig. 643.



Retractors.

periosteal elevator (Fig. 644), and, if an ordinary saw be used, a *resection-sound*,¹ Dr. Prince's probe-pointed grooved retractor, or, which in some cases will answer

Fig. 644.



Periosteal elevators.

every purpose, an ordinary broad lithotomy staff, grooved on the back, which may be readily slipped under the bone and then turned with its convexity upwards. When, however, the Butcher's or chain-saw can be used, these

¹ See Vol. IV., page 62.

instruments will be unnecessary; the great advantage of the *Butcher's saw* is that its blade can be so reversed as to cut from below upwards, and in doing this care must be taken that the teeth of the saw point *backwards* instead of *forwards*; the obvious reason for this is that in sawing *downwards*, the force of the arm is applied in *pushing*, but in sawing *upwards*, in *pulling*, and the blade of the instrument must be arranged accordingly. When the *chain-saw* is used, it may be simply slipped over the part to be removed, after disarticulating, or, in operations on the continuity of the long bones, may be adjusted by detaching one of the handles and tying the chain to a strong curved needle, which can be guided around the bone, or by employing an ingenious conductor devised for the purpose by the late Dr. Gurdon Buck, of New York.

GENERAL RULES FOR EXCISION.—The particular operative procedures which are required for excision or resection in the different regions of the body, vary of course with the locality, and with the special parts which are to be removed. It may be said, however, in general terms, that the external incisions, while not needlessly large, should be sufficiently free to allow fair exposure of the bones, and that they should lie, as much as possible, in the lines of the intermuscular spaces, so as to avoid unnecessary destruction of tissue. It is well, if convenient, though it is by no means essential, to make the incisions include the openings of any sinuses that may be present; they should always be so placed as to avoid any risk of injuring the principal bloodvessels and nerves. The periosteum should, for reasons already given, be preserved, when it is practicable to do so, and, as a rule, the amount of bone removed should be as small as may be consistent with the complete extirpation of the diseased structure. A good plan, in excising joints, is to take away only a thin layer of bone with the saw, and then to attack any remaining patches of caries or necrosis with the gouge, osteotrite, or trephine. The line of epiphyseal junction should not be encroached upon in operations upon children, lest the subsequent growth of the limb should be interfered with; and even in cases of adults it is important to avoid laying open the medullary canal, implication of which greatly increases the risk of destructive osteomyelitis—an affection which, as is well known, is often followed by pyemia and death. Care must be taken, in all excisions, not to mistake bone which is merely inflamed and softened (in a condition of *medullization*) for that which is actually carious, nor bone which, as the result of inflammation, is simply thickened and roughened, for that which is necrosed.

No matter how much altered in appearance the skin may be—even if it is riddled with sinuses—it and the superficial fascia should be preserved entire; the flaps, though they may at first seem redundant, will ultimately shrink and resume their natural condition. The degenerated synovial lining of the articulation may, however, advantageously be cut away with the knife-bladed forceps; and Volkmann, of Halle, even goes so far as to recommend complete “extirpation” of the joint capsule.

I am not in the habit of employing any tourniquet, or other means of controlling the circulation, during ordinary excisions, believing it safer to go slowly, and tie, if necessary, each bleeding vessel as it is cut. There are, however, no large arteries divided during the operation, and it not unfrequently happens that, when the incision is completed, no ligatures are required. The only case in which I have ever seen fatal hemorrhage after a joint-excision, was one at the Children's Hospital, in which my colleague, the late Dr. H. Lenox Hodge, used the Esmarch bandage—then a surgical novelty—in a case of excision of the knee. The operation, in which I assisted Dr. Hodge, presented no complication, and the wound appeared per-

fectly dry when it was closed; but a few hours afterwards, when the patient (a little girl) had become warm in bed, reactionary hemorrhage set in, and, in spite of all the measures that were adopted—including, finally, opening and plugging the wound with lint—bleeding continued, until the child fell into a state of exhaustion from which she never rallied.

Hemorrhage having been controlled, the wound should be closed with sutures—leaving, however, ample openings for free drainage, which should be promoted, if necessary, by the introduction of Chassaignac's tubes—and then lightly dressed with oiled lint, or with whatever material the surgeon may fancy, and the limb supported with a bracketed splint, or otherwise, in such a manner that the wound itself may be examined and dressed without unnecessarily disturbing the neighboring parts. If the olive-oil dressing be used—and I know of nothing better—it should be covered with oiled silk to keep it moist, as it is desirable that the wound should not be meddled with for at least forty-eight hours after the operation.

The after-treatment of excisions is that of operations in general.¹ In the case of adults, anodynes will probably be required during the first few days, but I have not usually found them necessary with children. Carbonate of ammonium should be given in from two to five-grain doses every hour, or every two hours, until reaction is fully established, and then a simple febrifuge during the period of traumatic fever; after a few days quinine may be added, and may be combined with iron if suppuration be very free. Milk is the best article of diet at first, and, if there be nausea, should be slightly diluted with lime-water. In the later stages of the case concentrated food will be required, and probably alcoholic stimulants in quantities proportioned to the patient's age and general condition.

The most frequent causes of death after excision I have found to be tuberculous and amyloid disease—causes connected therefore rather with the patient's state before operation than with the operation itself. If it be evident that the general health is failing to such an extent that repair cannot be hoped for, the surgeon should advise amputation, which may often be performed under these circumstances with the most gratifying results. But as long as the patient's strength is fairly well maintained, the attempt to save the limb should not be discontinued on account of apparent want of improvement in the local condition; a year, or even longer, is not too much time to devote to the after-treatment of a hip or knee excision, and even if caries, necrosis, or deformity should recur, all hope should not be abandoned, for a *re-excision* may sometimes be successfully practised in such a case.

SPECIAL EXCISIONS.

EXCISIONS OF BONES OF THE HEAD AND TRUNK.

The operation of *trephining the skull* is an example of partial excision, and is sometimes treated of as such in systematic works on operative surgery. Its interest and importance, however, are so clearly dependent on the proximity of the brain to the part operated upon, that I shall not consider it in this place, but will refer the reader to the article on Injuries of the Head, where it can be more appropriately dealt with. Similarly, the operation of

¹ See Vol. I. p. 458.

trephining or *resection of the vertebrae*, is almost exclusively of interest in connection with traumatic lesions of the spine—though the operation has occasionally been attempted in cases of disease, as by Heine, Roux, Holscher, Dupuytren, and Jacobi, and more recently, for the evacuation of spinal abscesses, by Israel and A. Jackson—and I shall therefore refer the reader for its consideration to the article on Injuries of the Back, where the history and statistics of the procedure are fully set forth, merely adding here that, if the operation is to be done at all, it can be best accomplished, as recommended by Dr. McDonnell,¹ by making a free and deep incision, and then dividing with strong-cutting pliers the bony laminae on either side of the spinous process of the injured vertebra, and, after taking away a single arch, removing any additional portions of bone with the ordinary gouge-forceps.

In certain cases of severe injury of the face, chiefly as the result of gunshot wound, it may be necessary to remove shattered portions of bone, and smooth off projecting fragments; but for such exceptional and irregular resections as these, no definite rules can be given. Again, in certain cases of nasal tumor, the bony orifice of the nostril may be enlarged by clipping away its outer wall with gouge-forceps. But the only excisions of bones of the face, which I shall describe in this article, are those of the superior and inferior maxillæ.

EXCISION OF THE UPPER JAW.—Trephining of the antrum, and even partial excision of the superior maxilla, appear to have been practised occasionally during the last century² and the early part of this; but the first proposal to excise the whole upper jaw for tumor appears to have been made by Lizars, of Edinburgh, while the first surgeon who is known to have actually accomplished the operation was Gensoul, of Lyons, in 1827.³ Lizars and the elder Textor repeated the operation in 1828, and Lizars again, and Léo in 1830. Gensoul, alone, had removed the jaw seven times up to 1833. The operation is chiefly required in cases of tumor, either involving the jaw itself or situated behind it (naso-pharyngeal polypus), *temporary* or *osteoplastic resection* being by some surgeons preferred to complete excision under the latter circumstances.

Several varieties of incision have been practised for the removal of the upper jaw. Gensoul began with an incision extending from the inner angle of the orbit, downwards, through the upper lip, which was divided opposite the canine tooth; a second incision extended transversely outwards from the first, at the level of the nostril, to within a short distance of the lobe of the ear; and a third passed upwards from the end of the second to the external angle of the orbit. Lizars employed an incision from the angle of the mouth across the cheek to the malar bone, supplementing this cut, if more room was needed by one through the lip into the nostril, and by a short longitudinal incision at the outer extremity of that first made. Liston's method consisted in making one incision from the external angular process of the frontal bone through the cheek to the corner of the mouth; a second along the zygoma, joining the first; and a third from the nasal process of the maxilla, detaching the ala of the nose, and cutting through the lip in the mesial line. Velpeau's operation possessed an advantage over all of these, in its greater simplicity; a single curved incision, convex downwards, was carried from the angle of the mouth, upwards and outwards, to the malar bone, or if necessary to the external angle of the orbit; but this incision does not, it seems to

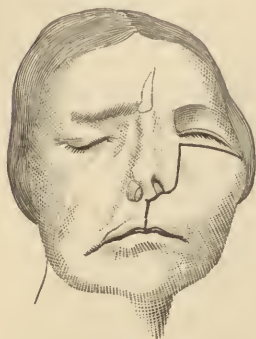
¹ Dublin Quarterly Journal of Medical Science, August, 1866.

² One of the most important operations of this kind was performed in 1820, by Dr. Jameson, of Baltimore. The first partial excision of the upper jaw is attributed to Aculuthus, in 1693.

³ Priority has been claimed for the late Dr. Alexander Stevens, of New York, but no account of his operation appears to have been published until many years afterwards.

me, give sufficiently ready access to the deeper and central portions of the wound, in case of hemorrhage, and though it is still a favorite with French surgeons, it is, I think, inferior to that which was introduced and recommended by Sir Wm. Fergusson, and which I have always found perfectly satisfactory.

Fig. 645.

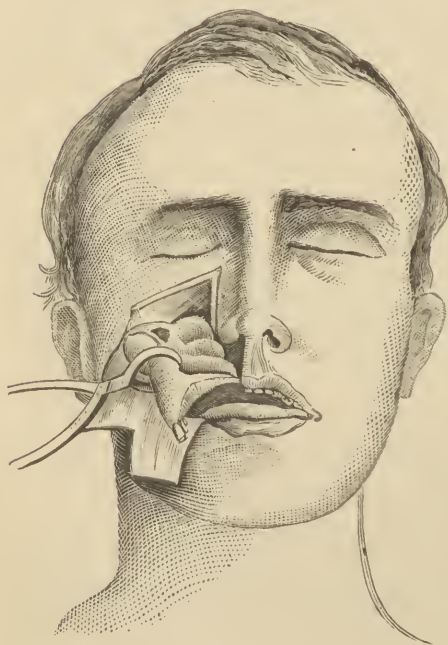


Incision for excision of the upper jaw by Fergusson's method.

Fergusson's operation (Fig. 645) consists in dividing the upper lip in the mesial line, laying open the nostril corresponding to the side of the tumor, carrying the knife from the root of the ala, between the side of the nose and the cheek, as far as the nasal bone, and then cutting transversely, opposite the lower border of the orbit, to the zygomatic process of the malar bone. The flap thus marked out being dissected up, sufficient room is furnished for the removal of the largest tumor. All of the integument covering the tumor should be scrupulously preserved, as if any "button-hole" be made in the flap, the subsequent contraction will leave a fistulous opening.

The tumor having been exposed, and the soft palate, if healthy, divided by a transverse incision, the bony attachments of the jaw may be severed with

Fig. 646.



Excision of the upper jaw.

a chain-saw or small resection-saw, or, which I think much better, with the strong cutting forceps known as Liston's.¹ The lateral incisor tooth of the affected side having been extracted, the blades of the forceps are made to cut a groove in the alveolus, and then one blade is applied in this groove and the other to the floor of the nostril, when, the handles being forced together, the hard palate is cut through at a single stroke. The malar bone is next cut across into the speno-maxillary fissure; or, if this bone is itself involved in the disease, its frontal and orbital processes, and the zygoma, are similarly divided. Lastly, one blade of the forceps is introduced into the nostril at its upper part, and the other into the orbit (the eye and surrounding tissues being held out of the way with the handle of a knife or a retractor), and the inner angle of the orbit cut across. The mass may now be seized with the lion-jawed forceps of Fergusson, and firmly depressed, fracturing the posterior attachments of the jaw, when removal is readily completed with a few touches of the knife. (Fig. 646.) Hemorrhage having been checked by the ligation of the internal maxillary

¹ See Fig. 128, Vol. I. p. 579, and Fig. 637, *supra*.

artery (if it can be seen) and of any other vessels that are found bleeding, or by the application of the hot iron, the external incisions should be accurately adjusted with the hare-lip or shotted suture. A piece of lint, wet with glycerine and water, and laid over the part, is all the dressing that is needed.

Partial excision of the jaw may, in cases of non-malignant growth, often be substituted for complete extirpation; thus, on the one hand, the orbital plate may be preserved, a groove being cut with the saw across the bone below the orbit, and the cutting forceps then applied in the same line; or, on the other hand, the alveolus and hard palate may be left, the bone being cut across above these, and the rest of the operation completed in the ordinary manner. Fergusson suggested that it might be sometimes advisable to cut into the centre of the diseased mass, and then work outwards with gouge and gouge-forceps, instead of resorting to formal excision. In cases of *small tumor*, and in those of *necrosis*, removal may often be effected from within the mouth, without making any external wound whatever, and Dr. Hutchison, of Brooklyn, has even succeeded in extracting through the mouth, in a case of necrosis, the whole upper jaw and malar bone. Linhart, of Berlin, has thus removed the greater portion of both upper jaws, while preserving the muco-periosteal covering of the hard palate and the incisor teeth.

The *statistics* of excision of the upper jaw are quite as favorable as could be expected, in view of the severity of the operation. Of 84 terminated cases of the operation, referred to by O. Heyfelder, 51 ended in recovery, and 33 in death or relapse (39 per cent.); and other authors give a still more favorable picture. Thus, Prof. Agnew, from an analysis of a large number of cases collected for him by Dr. Hunter, finds that 120 operations gave 99 recoveries and only 21 deaths (17.5 per cent.), while 20 cases tabulated by Ohleman, of Bremen, give the high proportion of 17 recoveries, or 85 per cent. Partial excision, though less grave in the immediate results of the operation, is more often followed by fatal recurrence: 83 terminated cases referred to by O. Heyfelder, gave only 48 recoveries and 35 deaths or relapses (42.1 per cent.). Hence the inference is very clear that, in cases of malignant disease, total excision should be preferred. I have myself had occasion to remove the entire upper jaw in five cases, four of which ended in recovery, while the fifth proved fatal from secondary hemorrhage. Another case, in which I removed all of the jaw except the orbital plate, as a preliminary to the extirpation of a very large pharyngeal tumor attached to the base of the skull, also ended fatally, apparently from the shock of the latter operation.

The principal *risks* which attend excision of the upper jaw appear to be excessive *hemorrhage*, *shock*, and suffocation from the *entrance of blood into the air-passages*.

(1) *Hemorrhage* is always pretty free in the early stage of this operation, though less when Fergusson's median incision is adopted than when the cheek is laid open, and the facial artery cut therefore where it is of considerable calibre. The bleeding may be temporarily arrested by pressure, or by the application of a clip or serrefine, but if the patient is under the influence of an anæsthetic, so that haste is not important, it is as well to pause, and tie each vessel as it is divided. At the end of the operation, there is again free hemorrhage from the internal maxillary artery or its branches, and if there should be any difficulty met with in applying ligatures, the bleeding points should be promptly and thoroughly seared with the hot iron, which should always be in readiness. As a prophylactic against hemorrhage, Lizars, and others of the older surgeons, ligated the common carotid artery of the affected side as a preliminary procedure; but this plan has been long since abandoned as unnecessary, and as in itself adding considerably to the dangers of the operation. Digital compression of one or both carotids by the hands of an assis-

tant may, however, be employed with advantage. Ligation of the carotid may be rendered necessary by secondary hemorrhage, as in cases recorded by Mr. Wagstaffe and by Prof. W. H. Pancoast, of Philadelphia. Sir William Fergusson suggested that, as the chief source of bleeding was from the external wound, the ascending process of the superior maxilla, with the alveolus and hard palate, might be notched, if not entirely divided, before cutting into the cheek at all, thus completing the most tedious stage of the operation before making any incision into those parts which were most vascular.

(2) *Shock* is not as much a source of danger in cases of excision of the jaw alone, as in those, like my fourth case above referred to, in which the jaw is removed as a preliminary step in the extirpation of retro-maxillary tumors. It is probably diminished by the employment of anæsthesia.

(3) The *entrance of blood into the air-passages*, causing suffocation, is, on the other hand, no doubt more likely to occur when the patient is unconscious from the use of chloroform or ether, than if no anæsthetic be employed. It proved the cause of death in a case of retro-maxillary tumor operated on by Sir Prescott Hewett. To prevent such an accident, anæsthesia should not be pushed further than is really necessary, particularly in the latter stages of the operation, and an assistant should constantly clear out the mouth and pharynx with small sponges mounted upon short sticks. Nussbaum, regarding this as the chief source of danger in operations upon the jaw, advises the preliminary performance of a temporary tracheotomy, the glottis to be closed with a piece of oiled lint, and the anæsthetic to be administered through a tracheal tube. This plan has, with various modifications, been employed also by several other surgeons, but, I confess, seems to me adapted rather to complicate than to facilitate the operation; and I can but say the same of Rose's and Burow's suggestion, that the patient's head during the operation should be thrown backward so far as to allow the blood to escape from the nostrils. Gluck and Zeller advise that the trachea should be divided transversely between its third and fourth rings, a few days before the principal operation, and that its lower end should be fastened externally. The continuity of the windpipe is ultimately restored by a final operation after convalescence from those which have preceded it. This procedure is said to have been successful in dogs, and seems to me an experimental mode of treatment which might well be reserved for the *corpora vilia* of those animals. Trendelenburg and Gerster have devised ingenious tracheal tampons, to be used after tracheotomy, for preventing the entrance of blood and permitting the maintenance of anæsthesia through the tracheal wound. Stimson employs a tube to plug the larynx and pharynx during the operation, but introduces it through the mouth, and thus avoids the necessity of opening the trachea.

The *use of an anæsthetic*, in the operation of removing the upper jaw, has been objected to by many surgeons, as likely to increase the danger of the procedure; but I think that with care in administration, the risk of anæsthesia may be avoided, and that the shock is apt to be less than if no anæsthetic be used, and, indeed, the operation is so dreadful a one to the patient, that I should hesitate to propose it without offering the benefits of anæsthesia. As to the choice between ether and chloroform, the latter agent is commonly preferred, on account of its vapor not being inflammable by contact with the hot iron, which is often required in the ultimate stages of the operation. But of late I have given the preference to ether in these operations, as in all others, finding that there is no risk of setting the patient on fire if only the precaution be taken to remove the anæsthetic from his face a few seconds before the cautery is applied. I have the patient thoroughly etherized before beginning, and then renew the anæsthesia after the tumor is fully exposed and bleeding from the external vessels arrested; then the ether-cone can be

entirely removed while the operation is completed, and the hot iron used if necessary. If it be required, a few whiffs may be again administered before closing the external wound with sutures.

Excision of Both Upper Jaws.—Removal of the *greater part* of both upper jaws was first accomplished by Rogers, of New York, in 1824, but the first *complete* operation of the kind was done by the elder Heyfelder, twenty years subsequently. The incision for this operation, which is one of the gravest character, consists in a median division of the upper lip, with separation of both nostrils and transverse prolongations below the borders of the orbits—a duplication, in fact, of the operation advised for the excision of either jaw separately. When portions only of the maxillæ are to be removed, a plan suggested and successfully employed by Dr. Porter, of Boston, may be resorted to. This consists in making a **Y**-shaped incision, the leg of the **Y** dividing the upper lip and its arms entering the nostrils, which can then be pushed upwards so as to afford a considerable amount of room. The recorded *statistics* of this severe operation represent a mortality so moderate as to excite the suspicion that some fatal cases may not have been recorded, twenty-three cases tabulated by H. Braun giving but five deaths (21.7 per cent.). The figures are as follows:

Nature of operation.	Whole number of cases.	Recovered.	Died.
Complete extirpation for tumor	11	7	4
Partial or consecutive extirpation for tumor .	5	5	...
Excision for necrosis	7	6	1

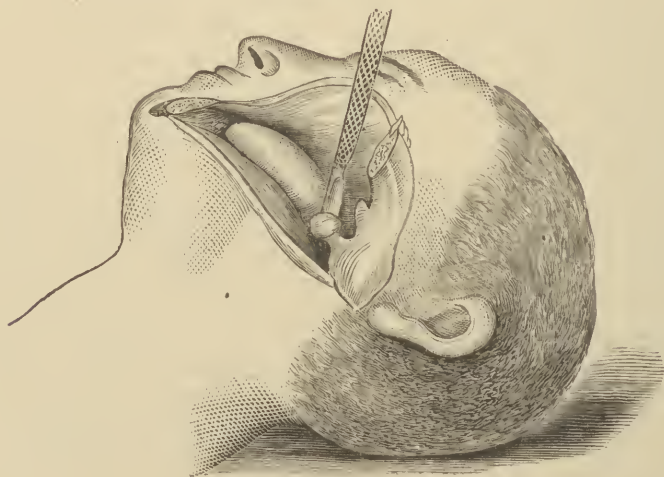
Temporary or osteo-plastic resection of the upper jaw, an operation designed to facilitate the excision of retro-maxillary growths without removing the bone, was suggested by Huguier in 1852 and 1854, but was not practised until about seven years subsequently, when Langenbeck and himself both operated at about the same time. Langenbeck, after making the necessary external incisions, divided the *upper* from the *lower* portion of the jaw, sawed through the connections of the former except at its nasal side, where it was left attached; and then turned it forcibly *inwards*, replacing it after the growth behind it had been removed. Huguier severed the *lower* from the *upper* portion of the jaw, and then forced the former, which retained its palatal attachments, *downwards* and *inwards*. Roux, of Toulon, suggested a procedure for the temporary displacement of the *whole* upper jaw, apparently in an *upward* direction; but he did not apply his operation on the living subject. Cooper Forster, finally, has practised osteo-plastic resection by displacing the maxilla *outwardly*. One or other of these operations, usually Langenbeck's, has been occasionally employed by other surgeons, including Esmarch, Wagner, Simon, Hill, and Verneuil, and in the majority of cases, apparently, with favorable results. In a case recently recorded by my colleague, Professor Agnew, the displaced jaw became spontaneously separated nine days after the operation, and was removed through the mouth as a sequestrum. Professor Cheever, of Boston, has *twice* operated successfully *on the same patient*; and this surgeon was the first to extend the method of osteo-plastic resection to *both upper jaws*. This case terminated fatally on the fifth day, but a similar operation, in the hands of Professor Tiffany, of Baltimore, has since proved completely successful.

EXCISION OF THE LOWER JAW.—As in the case of the upper jaw, when the operation is required for necrosis, the diseased bone may often be removed through the mouth without external incision, and Dr. Perry and Dr. Boker

have in this way each succeeded in removing the entire maxilla. In cases of non-malignant tumor, too, incision may sometimes be accomplished without external wound, as was twice done successfully by the late Mr. Maunder; and in any case of this kind it is very desirable, in order to preserve the symmetry of the face, to leave, if possible, the base of the jaw untouched—a mode of dealing with these growths which was practised long since by the late Dr. J. Rhea Barton, of Philadelphia, and the importance of which has been more recently insisted upon by Mr. Heath. If, however, the whole thickness of the bone on one side be involved, excision may be conveniently performed by making a single incision along the base of the jaw, prolonging the wound, if necessary, in a line corresponding to the position of the ascending ramus, and curving its anterior extremity upwards, toward, but not through, the prolabium. If the portion of bone which is to be removed should extend beyond the median line of the jaw, it would be necessary to pass a ligature through the tip of the tongue, so as to prevent its falling backwards when the muscles of the floor of the mouth were divided. The facial artery is necessarily cut in the first incision, and should be immediately secured before proceeding further with the operation. The flap, formed as above directed, should now be carefully dissected up, and, after extracting a tooth on either side of the tumor, the inner face of the jaw should be cautiously cleared by separating the soft tissues of the mouth. The bone may then be divided on each side with the chain-saw, or, if preferred, a deep groove may be cut through the alveolus with a small, straight saw, and the section completed with cutting pliers. The part to be removed is then seized with the lion-jawed forceps and wrenched out of its place, any remaining attachments being severed with a few touches of the knife.

If the angle of the jaw and ascending ramus be involved in the disease, it will be necessary to disarticulate the bone upon that side. Under these cir-

Fig. 647.



Excision of the lower jaw.

cumstances the incision must be extended upwards as far as the articulation, when the bone, having been cut through in front of the tumor, is cleared by cautious dissection and then pushed downwards, in such a way as to render tense and thus facilitate the division of the attachment of the temporal muscle to the coronoid process; the jaw being now twisted somewhat out-

wardly, the joint can be opened from the front, and disarticulation completed. (Fig. 647.) The edge of the knife must, throughout the operation, be kept close to the bone, lest the trunk of the facial nerve, or the internal maxillary, or even the external carotid artery, should be accidentally wounded. Ligatures having been applied to the bleeding vessels, and hemorrhage from the bone having been, if necessary, checked by the use of the Monsel's solution or the hot iron, the external wound is closed with sutures. If there is any tendency to retraction of the tongue, it should be kept well pulled forwards, by fastening externally the ligature which was passed through it, with strips of adhesive plaster. Until the wound has united, the patient's diet should be limited to liquid food, which may, if necessary, be administered through a tube.

The portio-dura nerve and the parotid duct are occasionally divided in this operation, and temporary facial paralysis, and sometimes a troublesome parotid fistula, therefore result. To avoid the risk of these complications, Dr. Lizars, of Toronto, recommends, instead of the incision above described, one passing from the commissure of the lips outwards towards the ear; he finds that disarticulation can be readily effected from within the mouth when its orifice is thus enlarged.

Metallie caps, arranged to fit the teeth of the remaining portions of the jaw, and connected by a spring to a similar appliance fitted to the teeth of the upper jaw, are sometimes employed to prevent the part from becoming disturbed by the action of the muscles. I have not, however, found it necessary to apply such an apparatus in those cases in which I have operated, and according to Mr. Heath it is never required, since the bone quickly resumes its normal position without assistance.

Removal of the entire lower jaw may be effected by means of a U-shaped incision dividing both facial arteries, as advised by Sir William Fergusson; or, as preferred by Mr. Heath, the lower lip may be split in the median line, and the flaps dissected back on either side.

Partial excisions of the lower jaw, in cases of gunshot injury, appear to have been practised by Desault and Fischer, in the latter part of the last century, but the first case in which partial removal of this bone was performed for tumor, was that of Deaderick, of Tennessee, in 1810. Ten years afterwards, according to O. Heyfelder, disarticulation of half the jaw was effected by a surgeon named Palm, while extirpation of the entire jaw, at one sitting, appears to have been first performed by Blandin, in 1848. The results of excision of the lower jaw are very favorable. I have not had occasion to remove the entire bone, but have excised large portions in six or seven cases, four of which were disarticulations, and only once with an unfavorable result. This was a case of malignant disease, in an old man, and it was also necessary to remove part of the floor of the mouth, the side of the tongue, and a portion of the palate; death occurred two days subsequently. The most extensive statistics of lower-jaw excision, with which I am acquainted, are those collected by Weber, which I borrow from the sixth edition of Prof. Gross's System of Surgery:—

Nature of operation.	Whole number of cases.	Cured.	Relapsed or died
Complete extirpation	20	19	1
Disarticulation of half the jaw	153	117	36
Excision in continuity	246	200	46
Aggregates.	419	336	83

Taking all the cases together, the proportion of deaths and failures is only 19.8 per cent.

Partial excision of the lower jaw is sometimes performed in cases of *anchylosis*, or of *closure of the jaws* from contraction following a burn, etc. *Esmarch's operation* consists in removing a wedge-shaped portion of bone, three-quarters of an inch wide at its upper part and an inch below, from the horizontal ramus of the jaw in front of the ascending cicatrix. According to Schulten, 40 cases of this operation gave only 2 deaths; but, on the other hand, only 15 permanent recoveries. Failure is apt to ensue from the parts coming together again and gradually closing the gap, as occurred in a case operated upon by the late Dr. Gurdon Buck, of New York, although he removed 10 less than an inch and a half of bone. Humphry, Bottini, Little, and Abbe, have successfully excised the *condyle of the lower jaw* for anchylosis of the temporo-maxillary articulation.

EXCISIONS OF THE STERNUM.—Trephining of the sternum in cases of *caries* or *nerosis*, is an operation which dates back to the days of Galen. The same operation has been employed in cases of *mediastinal abscess*, but cannot be recommended in that affection, as the pus can be more safely evacuated by an incision alongside of the bone. Larrey removed about half of the sternum in a case of *compound fracture*, and Linoli, an Italian surgeon, excised the ensiform cartilage, which was bent backwards, to relieve *uncontrollable vomiting*; though the peritoneal cavity was opened, the patient made a rapid recovery, and is said to have been permanently cured. These partial excisions seem to have been quite successful, 18 terminated cases, tabulated by O. Heyfelder, having given 17 recoveries and only one death. The only case with which I am acquainted in which the *entire sternum* has been removed, is that recently recorded by König. In this remarkable case, the whole sternum is said to have been excised on account of a sarcomatous tumor by which it was occupied; the pericardium and both pleural cavities were opened in the operation, the wound became gangrenous, and the heart was afterwards surrounded with pus; notwithstanding this, the wound slowly healed, and the patient ultimately recovered. Küster has also resorted to resection of the sternum to facilitate the removal of a mediastinal tumor.

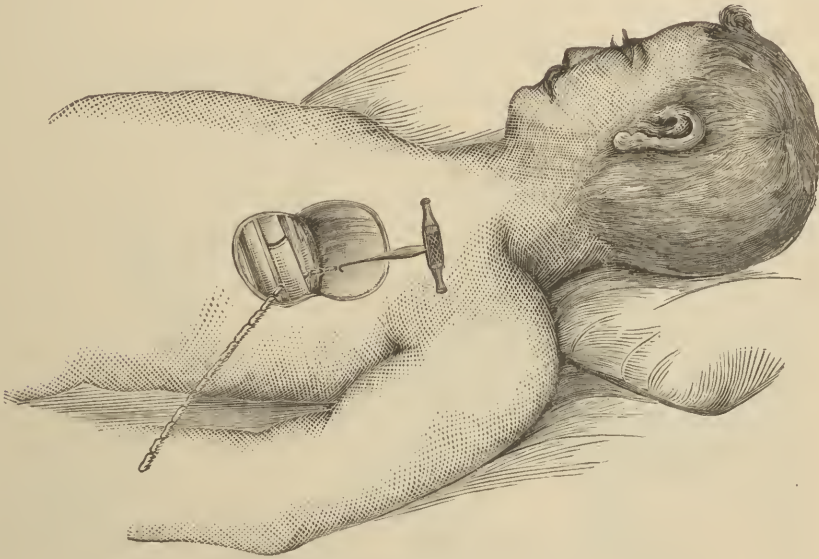
If it be thought proper to resort to excision of the sternum, partial or complete, the bone may be exposed by a longitudinal, a T-shaped, or a crucial incision. If the whole bone is to be removed, the costal cartilages may be carefully divided close to the sternum with strong knife or cutting pliers, retractors or the "resection-sound" being interposed to prevent injury of the pleuræ. The bone can then be drawn forwards, and cautiously disarticulated from the clavicles. For partial excisions, it is more convenient to begin by taking away one or more disks of bone with the trephine, and then to complete the operation with the gouge or gouge-forceps.

EXCISIONS OF THE RIBS.—*Partial excisions* of the ribs have been familiar to surgeons since the days of Celsus, and *complete excisions* of floating ribs are attributed to Fiori and the elder Heyfelder, the first-named surgeon's case having terminated successfully, but the other's patient having died from peritonitis. The operation has been usually practised in cases of *caries* or *nerosis*, *compound fracture*, or *hemorrhage from an intercostal artery*; of 37 cases referred to by O. Heyfelder, only 8 proved fatal. Resections of the ribs for *tumors* have been practised by several surgeons, including Langenbeck, Warren, McClellan, Gibson, Kolaczek, and Fischer. A remarkable case has been recorded by Alsberg, in which, besides portions of several ribs, a segment of the diaphragm was excised, and cases of rib-excision followed by

partial removal of the lung are attributed to a surgeon named Suif, and to Dr. Milton Antony, of Georgia. Resection of one or more ribs for *empyema*, as a substitute for the use of a drainage tube after paracentesis, appears to have been first employed, in this country at least, by the late Dr. Warren Stone, of New Orleans. The operation has been since strongly recommended by Roser, Peltavy, and Estlander, and has been practised, usually with good results, by numerous surgeons, including T. G. Richardson, Simon, Taylor, Howse, Thomas, Ashby, Marshall, König, Wagner, Lange, Fenger, Bruglocher, and J. William White, of Philadelphia. Schneider reports a recovery after resection of five ribs and the clavicle, for empyema following gunshot injury.

The operation of resecting a rib is not particularly difficult, the chief points requiring attention being to avoid, if possible, wounding the pleura, and the intercostal artery and nerve. This is comparatively easy in cases of necrosis, in which the periosteum can commonly be separated from the bone and pushed backwards, but is less readily effected when the operation is employed for compound fracture, and is usually impracticable in cases of tumor, in which indeed the pleura is itself very apt to be involved. In the operation for empyema, the pleura is of course opened, and a portion cut away with the bone. When only a single rib is to be resected, a straight incision following its course will afford sufficient exposure, but when the operation is to involve more than one rib, it will be better to turn up a semilunar flap, as shown in Fig. 648. If the intercostal artery be divided, as it almost necessarily will

Fig. 648.



Resection of ribs.

be in cases of tumor or empyema, both ends should be immediately secured with ligatures. The rib itself may be severed with the chain-saw, or, in the case of a child, with strong cutting forceps.

EXCISIONS OF THE PELVIS.—Portions of the *innominate bones* have been occasionally removed in cases of caries or necrosis, and the acetabulum not unfrequently requires gouging after removal of the head of the femur for hip-disease. But these operations should hardly be dignified by the name of

excisions, any more than the extractions of separated fragments which may be required in cases of compound fracture from gunshot or other injury. Resection of the *pubic symphysis*, as a means of facilitating parturition, was suggested by Christophoris, some twenty-five years ago, and temporary resection of the same part was recommended by Pitois; two cases, however, in which the operation was practised by Galbiati, terminated fatally. Resection of the *descending ramus* of the pubis is recommended by O. Heyfelder in cases of fracture with compression of the urethra by a displaced fragment. The operation can be performed by placing the patient in the lithotomy position, and making a single incision in the line of the bone which is then divided with a chain-saw. Care must be taken not to wound the internal pudic artery, nor, if it can be avoided, the root of the corpus cavernosum. Trephining the *ilium* for the evacuation of psoas and pelvic abscesses has been practised by Fischer and Riedel.

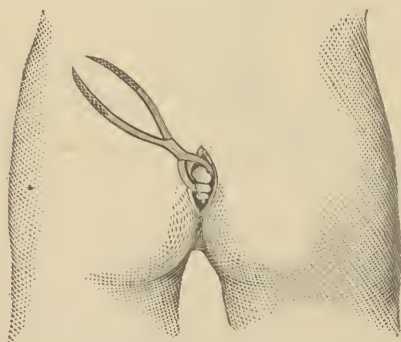
Partial resections of the *sacrum* have been performed by several surgeons, including Prof. Volkmann, the late Dr. G. C. Blackman, and Prof. S. D. Gross. The operation has been practised in cases of fracture, of necrosis, and of tumor, malignant or otherwise. The bone may be exposed by means of a T-shaped or crucial incision, and the diseased part separated with a chisel or cutting forceps; great care should be taken not to injure the sacral nerves. Several instances of trephining or gouging the sacrum for the removal of balls in cases of gunshot fracture, are referred to in the article on Injuries of the Back.

Excision of the Coccyx.—Occasionally employed in cases of fracture or dislocation of the part, and at least twice for osteitis or caries (Von Onsenoort's and Ollier's cases), this operation is most frequently practised for the relief of a neuralgic condition described by Sir J. Y. Simpson, and known as *coccyodynia* or *coccygodynia*. The first excision of the coccyx for this cause appears to have been performed by the late Dr. Nott, formerly of Mobile, and afterwards of New York, and the operation is of so simple a nature, and usually gives such satisfactory results, that it has been frequently repeated by other surgeons. I have twice excised the coccyx for coccygodynia, and in both instances with the effect of giving entire relief from the pain which had been long continued, and, at times, agonizing.

As after other operations for neuralgia, the benefit derived is sometimes only temporary; but as the operation is quite free from risk and involves no mutilation—consisting, indeed, in the removal of a mere useless appendage—it may be properly resorted to in any case in which it seems to be indicated.

The bone is exposed by a single longitudinal incision, and after it has been freed from its muscular attachments, which can be conveniently done with the blunt-pointed resection knife, is cut away with strong forceps, as shown in Fig. 649. This plan is much easier than attempting to

Fig. 649.



Excision of the coccyx.

effect disarticulation, and is perfectly satisfactory. Dr. Garretson has removed the coccyx piece-meal, by drilling with the "dental engine."

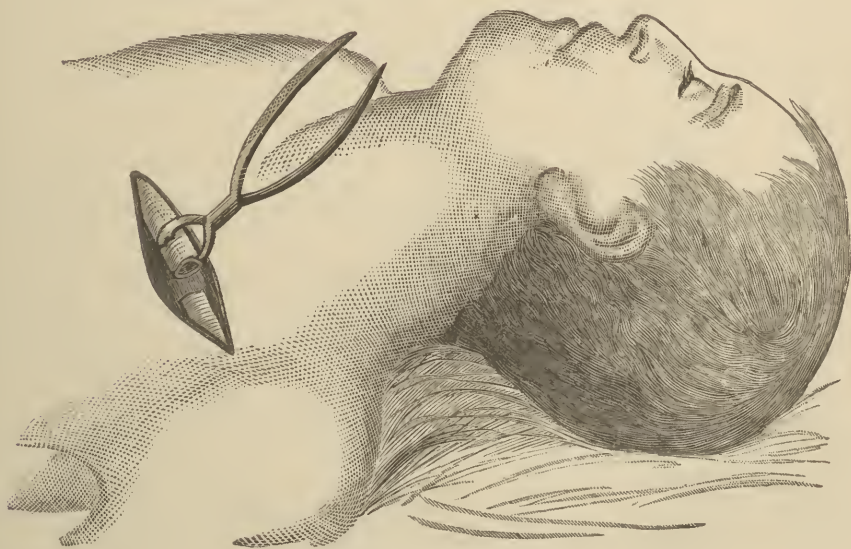
Excision of the coccyx has been recommended and practised by Verneuil as a means of obtaining more room in operations upon the lower part of the rectum.

EXCISIONS IN THE UPPER EXTREMITY.

EXCISION OF THE CLAVICLE.—The clavicle, in whole or in part, has been frequently excised in cases of caries or necrosis, of compound fracture, and of tumor. The inner end of the bone has also been removed by Davie, of Buncay, and other surgeons, on account of dislocation causing dangerous pressure on the trachea or œsophagus. An easy and usually a safe operation in cases of necrosis—in which, indeed, the procedure is often nothing more in reality than an extraction of sequestra—excision of the clavicle, in cases of tumor, is fraught with the greatest difficulty and danger; in Dr. Mott's famous case, the operation occupied nearly four hours, and the bleeding was so profuse that about forty ligatures were required. The first *complete extirpation* of the clavicle appears to have been performed by Dr. McCreary, of Kentucky, in 1811, and the second by a German surgeon, Dr. Meyer, in 1823. Remmer's operation (in 1732), often spoken of as an extirpation, was really only a partial excision, and the same must be said of Dr. Mott's case, already referred to, for its published history¹ states distinctly that the acromial end of the bone was not interfered with, and the autopsy made by Dr. Porcher and Dr. Michel, after the patient's death, 54 years subsequently, showed that the portion left measured one and three-quarter inches.²

The operation can be best accomplished by making first a long incision in the line of the clavicle, extending, if necessary, from the acromial junction

Fig. 650.



Excision of the clavicle.

to the sterno-clavicular articulation of the *opposite* side, supplementing this wound, in cases of tumor, by one or more at right angles to it, as may be found desirable. If a healthy portion of bone can be exposed, an elevator or resection-sound may be slipped beneath it—if possible, between the bone and

¹ Am. Jour. Med. Sciences, O. S., vol. iii. p. 100.

² Ibid., N. S., vol. lxxxv. p. 146.

its periosteum—and the part then cautiously divided with a chain-saw. If the central portion of the clavicle only be involved, the chain-saw may be used on both sides, and the same instrument, or a small resection-saw, will be found convenient to sever the acromio-clavicular junction when the disease extends to that point. At the sternal end of the clavicle, disarticulation may be very cautiously effected with the knife. The bone is then drawn upwards with Fergusson's forceps, as shown in Fig. 650, and the parts below carefully separated by using as much as possible the handle of the knife instead of its blade. Great care must be exercised to avoid wounding the pleura, as well as the important arteries, veins, and nerves, which lie in proximity to the bone; any vessels that are divided should be immediately secured with ligatures.

Statistics of extirpation of the clavicle have been published by O. Heyfelder, by the late Dr. Otis, and by Prof. Agnew, the last-named author having tabulated 34 cases, several of which, however, should be rejected as only partial excisions, while two (Nélaton's and Richard's, and Gunn's cases) were extirpations *à deux temps*, several months having, in each instance, intervened between the removal of the outer, and that of the inner portion of the bone. The following table, which, for the sake of convenience in reference, I have arranged alphabetically, embraces only 28 cases, all of which, however, appear to have been actual extirpations of the bone at one sitting:—

TABLE OF TOTAL EXCISIONS OF THE CLAVICLE.

No.	Operator.	Nature of case.	Result.	Reference.
1	Biangini,	Necrosis,	Recovered,	Gazette Médicale, p. 460. 1838.
2	Blackman,	Caries,	"	Western Lancet, vol. xvii. p. 336. 1856.
3	Bowe,	"	"	Med. Times and Gazette, vol. ii. p. 194. 1866.
4	Briggs,	Necrosis,	"	Nashville Journ. of Med. and Surgery, N. S., vol. xxi. p. 210. 1878.
5	Britton,	Cancer,	"	Brit. Med. Journal, vol. i. p. 518. 1870.
6	Carswell,	Caries,	"	Med. and Surg. Reporter, N. S., vol. xxxi. p. 299. 1874.
7	Cooley,	Osteo-sarcoma,	"	Richmond and Louisville Med. Journ., vol. viii. p. 620. 1869.
8	Curtis,	Malignant disease,	"	Am. Journ. Med. Sciences, N. S., vol. xxxiv. p. 350. 1857.
9	Dawson,	Necrosis,	"	Cincinnati Lancet and Observer, vol. xi. p. 1. 1868.
10	Esmarch,	Osteo-sarcoma,	"	Nissen, Dissertatio de Resectione. Kiliæ, 1859.
11	Eve,	Enchondroma,	Died,	Nashville Journ. of Med. and Surgery, N. S., vol. vii. p. 68. 1871.
12	Field surgeon,	Gunshot fracture,	"	Med. and Surg. Hist. of the War, First Surg. Vol. p. 557.
13	Heyfelder,	Necrosis,	"	Traité des Résections, trad. par Boeckel, p. 236. Paris, 1863.
14	Irvine,	"	Recovered,	Lancet, vol. i. p. 206. 1867.
15	Kunst,	Injury,	"	Deutsche Klinik, Bd. ii. S. 263. 1850.
16	McCrearry,	Necrosis,	"	Johnson, N. O. Med. and Surg. Journ., vol. vi. p. 474. 1850.
17	Mazzoni,	Osteitis,	"	Clin. Chirurg., t. iii. p. 120. Roma, 1876.
18	Meyer,	Caries,	"	Encycl. Wort. d. med. Wissenschaft., Bd. xxix. S. 96.
19	Morin,	Cancer,	"	Gaz. Méd. de Lyon, No. 8, p. 93. 1868.
20	Owens,	Osteo-sarcoma,	"	N. O. Med. and Surg. Journ., vol. xi. p. 164. 1854-5.
21	Palmer,	Gunshot fracture,	Died,	Tryon, Am. Journ. Med. Sciences, N. S., vol. xlix. p. 357. 1865.
22	Porquet,	Caries,	Recovered,	L'Année Médicale, t. ii. p. 84. Caen, 1877.
23	Roux,	"	Died,	Bull. Gén. de Thérap., t. vi. p. 246. 1834.
24	Travers,	Tumor,	Recovered,	Medico-Chirurgical Transactions, vol. xxi. p. 135.
25	Varick,	Necrosis,	"	N. Y. Med. Journ., vol. xxvii. p. 52. 1878.
26	Warren,	Osteo-sarcoma,	Died,	Surgical Observations on Tumors, p. 146. Boston, 1837.
27	Wedderburn	Caries,	Recovered,	N. O. Monthly Med. Register, vol. ii. p. 1. 1852.
28	Wutzer,	"	"	Orsbach, De resect. claviculæ. Bonnæ, 1833.

Of the whole 28 cases, only 6 proved fatal, a mortality of less than 22 per cent.

Partial excisions of the clavicle vary in severity from comparatively trifling affairs to such grave operations as those of Mott and Bartlett; Otis has collected 69 such cases, including those recorded during the War of the Rebellion; adding to these Mott's, Bartlett's, one of Wutzer's, Nélaton's, and Gunn's cases, incorrectly included by Dr. Otis among the cases of total excision, we have 74 cases, of which 59 recovered, and 10 died, the result in 5 being unknown; the mortality of determined cases, therefore, was but 14.5 per cent.

EXCISION OF THE SCAPULA.—This operation may be required in cases of caries or necrosis, in those of tumor, and in some cases of severe lacerated wound or compound fracture, though in these it is often necessary to remove the upper extremity at the same time, the operation then being an “amputation *above* the shoulder,” as described in a previous portion of this Encyclopædia.¹

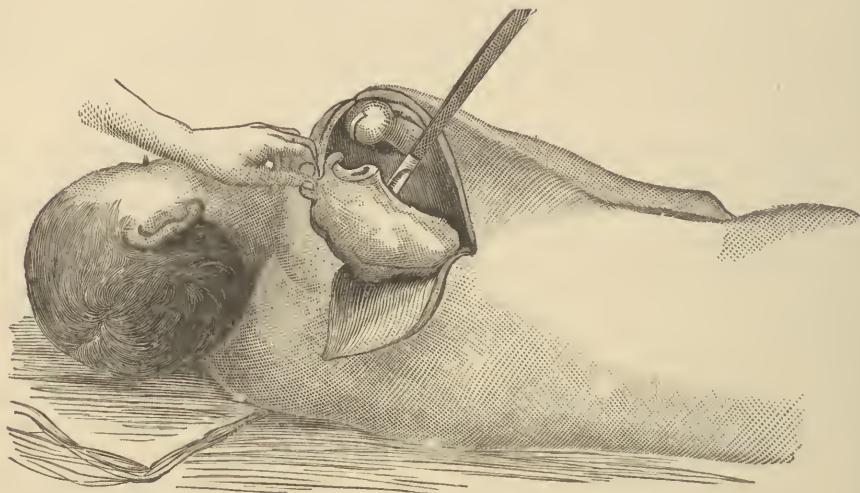
The scapula may be removed by means of a crucial, an H-shaped, a T-shaped, or, which is commonly preferable, a T-shaped incision, as advised by the late Prof. Syme, of Edinburgh; the transverse branch of the wound extends from the acromio-clavicular junction, following the spine of the scapula, to the posterior edge of the bone, and the longitudinal branch, starting from the centre of the other, passes downwards as far as may be necessary. In traumatic cases, as in those of caries or necrosis, the muscles should be carefully separated from the bone, which should be removed with as little disturbance of the soft parts as practicable; in cases of tumor, however, the external incisions should be only skin-deep, as the muscles will probably be found to be infiltrated by the morbid growth, and blood may be saved by not cutting into the tumor, which may be very vascular. Hemorrhage during the operation is, indeed, one of the chief risks in excision of the scapula, and every means should be taken to avoid it. For this purpose an assistant should compress the subclavian artery with a padded key over the first rib, and, since there is apt to be very free bleeding from the superficial parts of the wound, it is well not to make the whole incision at first, but to begin with a cut of moderate size, and afterwards enlarge it when more room is found necessary. It is recommended by Sir W. Fergusson and Mr. Pollock to free the posterior border of the scapula first, and then the inferior, turning up the bone from below as the operation is continued. By doing this, the pulsation of the subscapular artery can be felt for, and the vessel controlled with the finger before it is divided. Prof. Spence, however, from practical experience with both methods, advises that the clavicular attachments should be first severed, so as to permit an assistant to control the subclavian artery by direct compression.

If the operation be performed for *malignant disease*, the whole scapula should be excised (Fig. 651), but, under other circumstances, it may be better to substitute partial excision; and there is certainly an advantage in retaining the neck of the bone and the glenoid cavity (not opening the joint), with the acromion and coracoid processes, when nothing can be gained by their removal. Under these circumstances, the bone is to be divided at the proper points with the saw or cutting forceps, and even in complete excision, it will commonly be found more expeditious to use the saw at the acromio-clavicular junction than to attempt disarticulation. The coracoid process also may be sawn through at any convenient point, and its tip afterwards dissected out when the removal of the tumor has been completed. In order to free the

¹ See Vol. I. p. 653.

glenoid cavity, the joint should be opened, and the capsular ligament then carefully divided with the probe-pointed knife or with scissors.

Fig. 651.



Excision of the scapula.

The mass having been removed, all bleeding vessels are to be secured, drainage tubes introduced, and the wound then closed with stitches. The arm may be placed upon a Stromeier's cushion,¹ until the flaps have fairly united, and the arm afterwards simply supported in a sling.

It may sometimes be necessary to remove, with the scapula, a portion of the clavicle, the head and neck of the humerus, or both. These additions to the operation of course greatly increase its gravity, and the parts in question should not be interfered with, if such a course can possibly be avoided.

The *acromion process* or the *spine of the scapula* may readily be removed through a single transverse incision.

The history and statistics of excision of the scapula were made the subject of special investigation by the late Dr. Stephen Rogers, of New York,² and have been more recently studied by Prof. Adelmann, of Berlin,³ who, however, has failed to make any distinction between excisions of the scapula proper, and operations in which the upper extremity has been removed at the same time, or amputations above the shoulder. The first case in which the entire scapula was extirpated, the arm being preserved, was that of Langenbeck, who, in 1855, thus removed the whole shoulder-blade with three inches of the clavicle. In the following tables I have arranged by the names of the operators, in alphabetical order, (1) 42 cases in which the whole scapula appears to have been excised, *the arm being preserved*, and (2) 14 cases in which total excision has been resorted to *subsequent to amputation at the shoulder*, but not at the same operation. The results in two cases of the first category have not been ascertained, leaving 40 determined cases with 32 recoveries and 8 deaths, a mortality of exactly 20 per cent. The 14 cases of the

¹ See Vol. II. p. 160, Fig. 275.

² Am. Journ. Med. Sciences, October, 1868, and New York Med. Journal, December, 1870.

³ Prag. Vierteljahrsschrift, Bd. 144, 1879.

second category gave 11 recoveries and 3 deaths, a mortality of over 21 per cent. The results of complete are thus somewhat more successful than those of partial excision of the scapula, 206 recorded cases of which operation have given at least 49 deaths, a mortality of nearly 24 per cent.

Prof. Adelman tabulates 195 cases as examples of partial excision, from which number 4 should be deducted as cases of amputation above the shoulder, and one as a case of total excision (King). To the remaining 190 are to be added 4 from Prof. Adelman's table of complete excisions (Skey, Langenbeck, Fergusson, Sydney Jones), and 12 additional cases recorded by Péan, Zimmerman, Bœckel (two), Fischer (two), Nedopil, Berkeley Hill, Kurtz, Wolcott, Bellamy, and Ball, making a total of 206, as given above.

TABLE OF TOTAL EXCISIONS OF THE SCAPULA, THE ARM BEING PRESERVED.

No.	Operator.	Result.	Reference.
1	Agnew,	Died,	Record of Hospital of University of Pennsylvania.
2	Bellamy,	Undetermined,	Lancet, Oct. 9, 1880.
3	Billroth,	Recovered,	Archiv f. klin. Chirurgie, 1879.
4	Bird,	"	Lancet, 1865.
5	Brigham,	"	Boston Med. and Surg. Journal, June, 1878.
6	Busch,	"	Adelmann, Prag. Vierteljahrsschrift, Bd. 144.
7	Choppin,	Died,	N. O. Med. News and Hosp. Gazette, Jan. 1857.
8	Crawford,	Recovered,	Med. Times and Gazette, 1857.
9	Esmarch,	"	Arch. f. klin. Chirurgie, 1863.
10	Hamilton,	"	Med. and Surg. Reporter, 1866.
11	Hammer,	"	St. Louis Med. Reporter, 1866.
12	Heath,	Died,	British Med. Journal, 1879.
13	Heyfelder,	"	Deutsche Klinik, 1857.
14	Jones,	Recovered,	Medico-Chirurgical Transactions, vol. xlii.
15	King,	"	Liverpool and Manchester Reports, 1874.
16	Kottman,	"	Corr. f. d. Schw. Aertz., 1874.
17	Langenbeck,	"	Deutsche Klinik, 1855.
18	Linhart,	"	Adelmann, loc. cit.
19	Logan,	"	Richmond and Louisville Med. Journal, 1872.
20	MacCormac,	"	Lancet, 1876.
21	Mazzoni,	"	Arch. di Chir. Prat., and Schmidt's Jahrb., Bd. 174.
22	Michaux,	"	Gazette Médicale de Paris, 1866.
23	Michel,	"	Gazette Hebdomadaire de Méd. et de Chirurgie, 1874.
24	Nixon,	"	British Med. Journal, 1881.
25	O'Grady,	"	Dublin Journal of Med. Science, 1873.
26	Id.	"	British Med. Journal, Dec. 3, 1881.
27	Omboni,	"	Raccogl. Med., and Richm. and Louisv. Med. Journ., 1875.
28	Orlowski,	"	Centralblatt für Chirurgie, 1878.
29	Peters,	"	Am. Journ. Med. Sciences, 1878.
30	Pirrie,	"	Principles and Practice of Surgery, 1873.
31	Pollock,	Died,	St. George's Hospital Reports, 1869.
32	Rogers,	Recovered,	Am. Journ. Med. Sciences, 1868.
33	Schneider,	"	Berlin. klin. Wochenschrift, 1874.
34	Schuh,	"	Wien med. Wochenschrift, 1860.
35	Schuppert,	"	New Orleans Journ. of Medicine, 1870.
36	Spence,	"	Lectures on Surgery, 3d ed., vol. ii. p. 963.
37	Id.	Died, ²	Ibid. p. 967.
38	Steele,	"	British Med. Journal, 1871.
39	Syme,	"	Excision of the Scapula, 1864.
40	Id.	Recovered,	Ibid.
41	Wood,	Undetermined,	Lancet, 1875.
42	.....	Recovered,	Dublin Med. Press, Nov. 13, 1861.

¹ Patient recovered from operation, but died from recurrence of disease.

² It is not mentioned in so many words, but the manner in which Prof. Spence speaks of this case renders it almost certain that it proved fatal.

TABLE OF TOTAL EXCISIONS OF THE SCAPULA AFTER PREVIOUS AMPUTATION AT THE SHOULDER-JOINT.

No.	Operator.	Result.	Reference.
1	Buck,	Recovered,	Rogers, Amer. Journ. Med. Sciences, October, 1868.
2	Busch,	"	Lehrb. d. top. Chirurgie, 1864.
3	Conklin,	"	Amer. Journ. Med. Sciences, January, 1883.
4	D'Ambrosio,	Died,	Movimento (Napoli), 1880, t. xii. p. 393.
5	Deroubaix,	Recovered,	Gazette Médicale de Paris, 1866.
6	Fergusson,	"	Medico-Chirurgical Transactions, vol. xxxi.
7	Jeaffreson,	"	Lancet, 1874.
8	Krakowizer,	Died,	New York Medical Journal, 1869.
9	Langenbeck,	Recovered,	Archiv f. klin. Chirurgie, Bd. iii.
10	Mussey,	"	Amer. Journ. Med. Sciences, 1837.
11	Rigaud,	"	Archives Gén. de Médecine, 1844.
12	Id.	"	Bull. de la Soc. de Chirurgie, 1875.
13	Soupart, ¹	Died,	Gazette Médicale de Paris, 1866.
14	Stimson,	Recovered,	Medical Record, Dec. 16, 1872.

EXCISION OF THE SHOULDER-JOINT.—Excision of the head of the humerus, or of the entire scapulo-humeral articulation, may be required in cases of destructive inflammation of the joint, caries or necrosis, compound fracture or dislocation, or non-malignant tumor. For cases of malignant growth, including sub-periosteal sarcomata, amputation is undoubtedly preferable, as permitting more thorough extirpation of the diseased structures; but in a case of enchondroma of moderate size, or in one of central sarcoma (if it could be recognized as such), I should be strongly tempted to substitute excision, which under these circumstances would probably be no more liable to be followed by recurrence than amputation, while it would of course have the advantage of giving a chance for the preservation of a fairly useful limb. The most frequent cause for excision of the shoulder is gunshot injury, and this operation is of all excisions in military surgery that which has upon the whole given the most favorable results. This point may be illustrated by the annexed table, borrowed from Gurlt, showing the "end-results" of the various joint incisions recorded during the Franco-German War.

TABLE SHOWING ULTIMATE RESULTS AFTER EXCISIONS OF THE LARGER JOINTS FOR GUNSHOT INJURY.

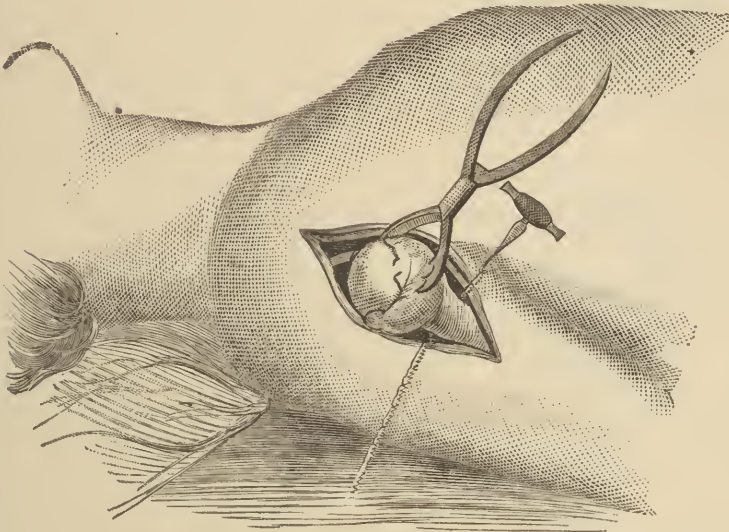
Seat of operation.	No. of cases.	Result of operation.					Per cent. of good results.	Per cent. of medium results.	Per cent. of bad results.
		Very good.	Good.	Medium	Bad.	Very bad.			
Shoulder . . .	213	4	90	102	17	...	44.1	47.9	8.0
Elbow . . .	355	20	84	189	51	11	29.3	53.2	17.5
Wrist . . .	16	...	1	8	6	1	6.2	50.0	43.7
Hip . . .	4	1	3	...	...	...	100.0	.....	.....
Knee . . .	9	5	3	...	...	1	88.9	.....	11.1
Ankle . . .	55	8	21	23	1	2	52.7	41.8	5.5
Aggregates	652	38	202	322	75	15	36.8	49.4	13.8

The shoulder-joint may be readily exposed by making either a rectangular, a V-shaped, or a U-shaped flap; or, which is amply sufficient under ordinary circumstances, a single, longitudinal incision, which is best placed, after the manner of Baudens and Langenbeck, somewhat on the anterior surface of the

¹ The previous operation had been an amputation above the shoulder.

joint. (Fig. 652.) The knife is entered a little to the outer side of the coracoid process, and made to cut downwards and slightly outwards for about five inches, passing between the fibres of the deltoid muscle, and in the line of the bicipital groove. If this wound should not afford sufficient room,

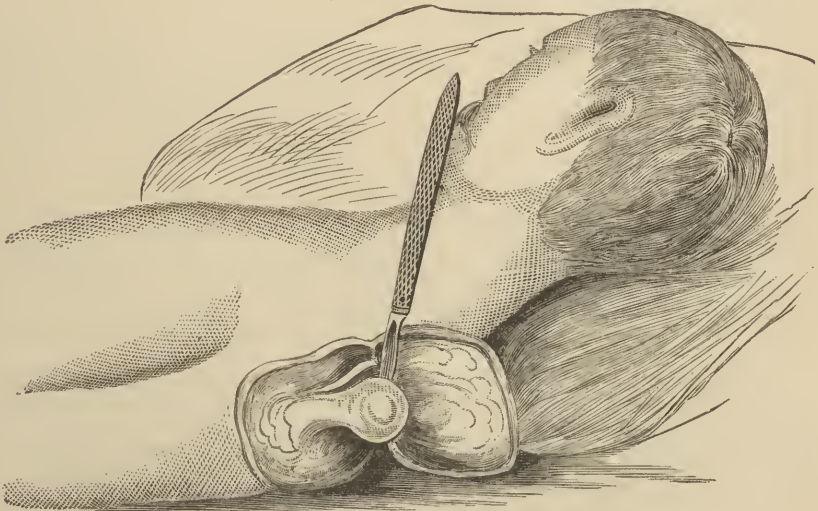
Fig. 652.



Excision of shoulder-joint by single longitudinal incision.

as may happen when the operation is practised in a case of tumor, it may readily be enlarged by adding a slight transverse incision at its upper end,

Fig. 653.



Excision of shoulder-joint by flap method.

either backwards over the acromion process, forwards over the clavicle, or in both directions, thus giving the wound the form of a T. Of the various

flap-operations, the best is probably that with a semilunar or U-shaped incision, as advised by Morel and Bell (Fig. 653), but it makes an unnecessarily large wound, and the transverse division of the fibres of the deltoid muscle renders the arm less serviceable than it would be under other circumstances.

It is a matter of some importance, when it can be done, to preserve the integrity of the long head of the biceps muscle, and this can usually be accomplished by carefully opening the sheath, and having an assistant hold the tendon to one side with a blunt hook or a retractor. The capsular ligament is then to be divided, and the tuberosities of the humerus successively rotated into the wound, and cleared from their muscular attachments by using the probe-pointed knife. Finally, the head of the bone is made to project by pushing the elbow first backwards and then upwards, and its neck is then cut through with the chain-saw. If the glenoid cavity be diseased, it can next be attacked with the gouge or gouge-forceps; or, if too extensively involved to be thus dealt with successfully, may be exposed, by the aid of a transverse incision if necessary, and removed with the saw as directed in speaking of excisions of the scapula. Hemorrhage having been arrested, a drainage-tube is to be introduced, and the sides of the wound accurately approximated by means of the interrupted suture. An olive-oil dressing may then be applied, and the arm may be supported upon a Stromeyer's cushion until the wound has been fairly consolidated, after which a simple sling will afford sufficient support. The advantage in using Stromeyer's cushion instead of an ordinary axillary pad, is that, by keeping the elbow somewhat forward and away from the side, the contraction of the wound is encouraged, and the ligamentous bands by which repair is effected are shorter than they would be otherwise.

The first formal excision of the head of the humerus *for disease* appears to have been successfully performed by Bent, of Newcastle (England), in 1771,¹ while the first excision of the entire scapulo-humeral articulation was performed, likewise successfully, by the elder Moreau, in 1786. The first excision for *gunshot fracture* was that of Percy, in 1792, and the first American case of the same kind that of Dr. W. Ingalls, of Boston, which occurred in the winter of 1812-13.

The operation is a very successful one, considering its magnitude, the death-rate in military surgery, as shown by the table on page 444, having been but 35.4 per cent., while in civil practice the results have been still more favorable, 115 terminated cases of excision for disease, tabulated by Culbertson,² having given but 21 deaths, a mortality of only 18.2 per cent.; comparing these figures with those of shoulder-joint amputation,³ which show a death-rate for all cases taken together of 37.7 per cent., it is obvious that, even as a means of saving life, excision, when admissible, is entitled to the preference.⁴ The advantages of this operation are made still more apparent by the consideration that, in the successful cases in Dr. Culbertson's table, 63, or more than two-thirds of the patients are known to have had useful limbs, while the "end-result" of the procedure in military practice was, according to

¹ The operations of Charles White (1768) and Vigaroux (1767), appear to have been excisions in the continuity of the humerus (see p. 43, note), while those of Schaeffenberg (1726), Thomas (1740), and Boucher (1745), were extractions of sequestra or fragments, and not formal excisions. A German surgeon, named Lentin, is said to have excised the head and greater part of the shaft of the humerus in 1771, the same year as that of Bent's operation.

² Prize Essay: Transactions Am. Med. Association, vol. xxvii., supplement. 1876.

³ See Vol. I. p. 653.

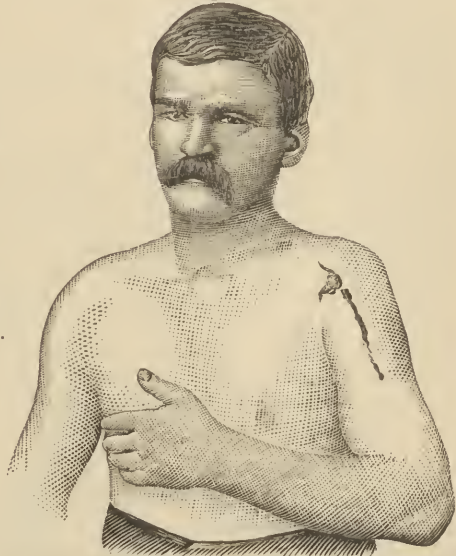
⁴ The statistics of the War of the Rebellion, taken by themselves, show a less rate of mortality for shoulder-joint amputation, the death-rate of which operation, as given by Drs. Otis and Huntington, was 29.1 per cent., as compared with 36.6 per cent. for excision. (Op. cit., Third Surgical Volume, pp. 875-877.)

Dr. Gurlt's statistics, quoted on page 584, "good" in over 44 per cent., "medium" in nearly 48 per cent., and really "bad" in only 8 per cent. of cases ending in recovery.

As may be inferred from what has already been said, excision of the shoulder is not very often required in civil practice. My own experience in excision of the larger joints now extends to over sixty cases, but only once have I had occasion to resort to this particular operation.

The patient was a man, about 30 years of age, who was admitted to the University Hospital in June, 1882. He was suffering from disease of the left shoulder-joint, of considerable duration, and two sinuses were discharging very profusely, one on the front of the arm, and one above the clavicle. After watching the case for a few weeks, I thought it right to operate, in spite of the prevailing hot weather, because the sinuses showed no disposition to heal under expectant treatment, and because a tendency to hectic and the presence of the physical signs of incipient phthisis rendered it almost certain that the patient's strength would fail if we delayed further, in hope of obtaining a spontaneous cure. Accordingly, on July 6, the patient having been carefully etherized, I made a longitudinal incision in the manner above recommended, and having turned out the head of the bone, divided its neck with a chain-saw. One edge of the glenoid cavity, only, required gouging, and the limb was then dressed upon a Stromeyer's cushion, in the way already described. In spite of the formation of one or two abscesses the patient convalesced without any really unfavorable symptom, and rapidly gained flesh and strength as his wound healed. The annexed illustration (Fig. 654), from a photograph, shows the appearance of the part before the patient left the hospital; he reported himself again, some six months afterwards, in excellent condition, and with a very useful arm, though the "overhand" motions, as is often the case, were somewhat defective.

Fig. 654.



Result of shoulder-joint excision. (From a patient in the University Hospital.)

RESECTION OF THE SHAFT OF THE HUMERUS.—The shaft of the humerus may occasionally require resection in cases of *compound fracture*, especially from gunshot injury, though I must confess that my own experience leads me to think that in cases in which simple extraction of the splintered fragments is insufficient, amputation will usually prove the better remedy. I have, however, seen an excellent result from cutting off the projecting end of bone in a case of compound fracture with protrusion, in which reduction could not otherwise be accomplished. The operation may also be required in some cases of *caries* or *necrosis*, and Dr. Shrady, of New York, has recorded a most successful instance of sub-periosteal excision of almost the entire humerus for *acute necrosis*. But the condition in which resection of the humeral shaft has won its greatest triumphs, is that of *ununited fracture*, and when the operation is done in the manner recommended by Ollier, of Lyons, and by Bigelow, of Boston, it is quite a successful procedure.

A single longitudinal incision is made on the outer side of the arm, where the bone is comparatively superficial, going through one of the muscular

interspaces, and taking care not to injure the musculo-spiral nerve, which, if exposed, should be carefully held out of the way with a retractor. The bone having been reached, the periosteum is divided and separated with the handle of the knife or with the elevator, and the ends of the fragments are then successively turned out and cut off with the chain-saw or small resection-saw, as may be found most convenient. Two fresh bone-surfaces having been thus obtained, the resected ends of the fragments are drilled, and a strong silver wire introduced and twisted to serve as a bone-suture. The external wound is then closed and lightly dressed, and the arm placed upon a bracketed or other convenient splint, so arranged that the dressings can be renewed without removing the whole apparatus. The wire which joins the fragments usually becomes loose in the course of five or six weeks, and may then be untwisted or cut, and gently withdrawn. When the external wound heals, the limb may be put up in a plaster-of-Paris bandage until osseous union is firmly established.

Dr. Macewen, of Glasgow, has reported a very interesting case in which reproduction of a humerus was effected by the transplantation of grafts of bone taken from other patients.

My individual experience in resection of the shaft of the humerus is limited to two cases: one of ununited fracture, with necrosis at the seat of injury, in which I operated in the manner above described with entire success; and one of severe gunshot fracture, in which, during the early days of the war, I adopted this operation in the case of a soldier of the 20th Massachusetts regiment, who had been wounded at the battle of Antietam. The case promised well for a week, when profuse secondary hemorrhage occurred, requiring amputation, from which the patient happily recovered. I also advised the operation in a case at the University Hospital, in which our house surgeon, Dr. R. H. Harte, successfully resected the protruding fragment in a case of otherwise irreducible compound fracture; and at the same hospital I directed the after-treatment of a case of ununited fracture successfully operated upon, in the manner described, by my colleague, Professor Agnew.

The statistics of excision in the shaft of the humerus, for gunshot fracture, are not very favorable, the mortality of all the cases recorded during the war of the Rebellion having been, according to Drs. Otis and Huntington,¹ 28.6 per cent., as compared with a mortality after amputation through the upper arm of only 23.8 per cent.² In many instances, the preserved arms appear to have been less useful than was at first anticipated. O. Heyfelder has tabulated 89 cases of this operation, for all causes, of which 17 ended in death and 16 more in failure; the unsuccessful results were therefore about three-eighths of the whole number.

Successful "total excisions" of the humerus have, according to Professor Gross, been recorded by Langenbeck, Billroth, and J. B. Cutter, of New Jersey.

TABLE SHOWING THE RESULTS OF EXCISION IN THE SHAFT OF THE HUMERUS FOR GUNSHOT INJURY.³

Period of operation.	Cases.	Recoveries.	Deaths.	Undetermined.	Mortality per cent.
Primary	487	326	145	16	30.7
Intermediate	93	64	29	...	31.1
Secondary	41	36	5	...	12.1
Unknown	75	51	12	12	19.0
Aggregates	696	477	191	28	28.6

¹ Op. cit., Part Third, Surgical Volume, page 875.

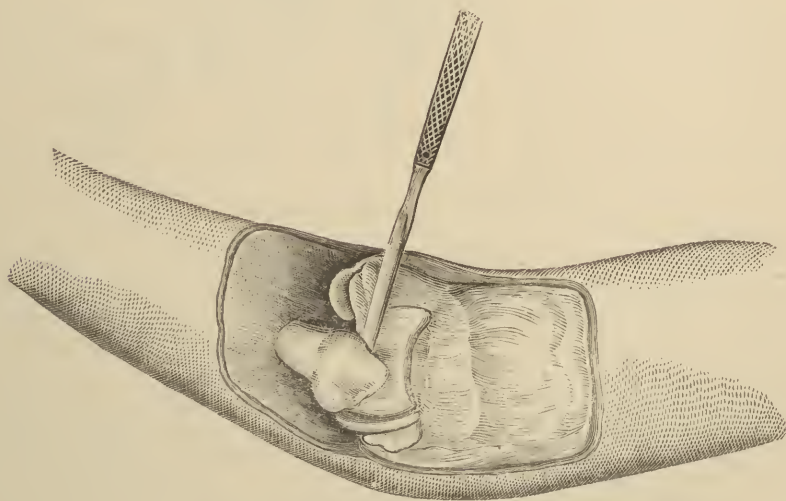
² Ibid., page 877.

³ Ibid., page 875.

EXCISION OF THE ELBOW-JOINT.—The elbow-joint may require excision on account of chronic disease involving the articulation (especially in cases of *strumous synovitis*, or, as I have preferred to call it, *gelatinous arthritis*), compound fracture or dislocation, or bony ankylosis. Even in cases of bony ankylosis with the limb in a good position, the operation may be properly resorted to in favorable cases, since the movable joint afforded by a successful excision is more useful than a stiff one.

The lower extremity of the humerus appears, as already mentioned, to have been resected by Wainman, of Shripton, England, in 1759, in a case of compound dislocation of the elbow; the operation was entirely successful, the patient surviving many years, and being able to “perform all the motions of the joint,” which was “as flexible as if nothing had ever been amiss.” This operation was repeated by Tyre, of Gloucester, likewise in a case of compound luxation, and with equal success, some twenty-five or thirty years afterwards; and about the same time, or a little earlier, Justamond successfully removed the olecranon and upper part of the ulna, in a case of caries.¹ But the first complete excision of the elbow-joint was performed by the elder Moreau, in 1794. The case was one of chronic joint-disease, and the patient recovered with a useful limb in the course of seven months. The first surgeon to introduce elbow-joint excision into military practice was the celebrated Percy, and the first case in American military surgery was that of Dr. Otis Hoyt, during the Mexican War, in 1847. The first American operation in civil practice was performed by Dr. John C. Warren, of Boston, in 1834.

Fig. 655.



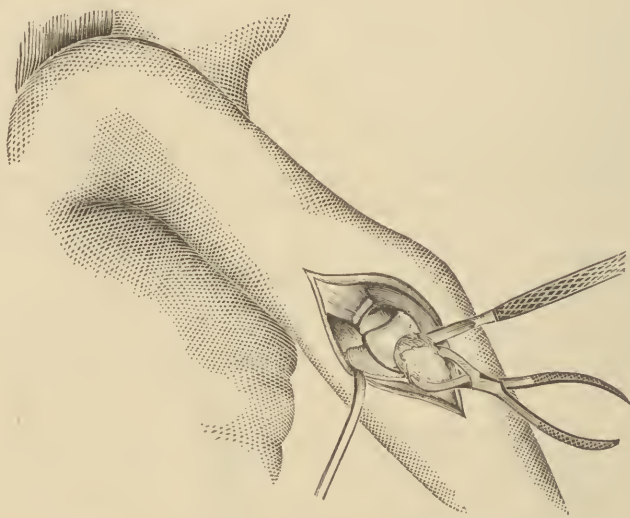
Excision of elbow-joint by H-shaped incision.

Various incisions have been recommended for excision of the elbow, many surgeons, including Mr. Butcher, of Dublin, and the late Prof. Syme, of Edinburgh, preferring an H-shaped wound, as shown in Fig. 655, while others

¹ In my “Principles and Practice of Surgery” (third edit. p. 627), I have, following Dr. Hodges, given the date of Justamond’s case as 1775; but in Park’s second letter, dated November 5, 1789, he speaks of this operation as having been performed since the publication of his first letter, which was in 1783.

dispense with one of the longitudinal branches, thus reducing the incision to the form of a T. The operation originally suggested by Park, however—a single longitudinal incision over the posterior, inner surface of the joint—affords abundant room in almost all cases, and has the advantage that the wound has no tendency to gape, and is thus better adapted for rapid healing. The incision begins (in an adult) about two inches above the olecranon, and extends three inches below it, the course of the wound being parallel to that of the ulnar nerve, and a few lines to its radial side. The only point requiring special caution in this operation is to avoid injuring the ulnar nerve, which should be carefully dissected from its position behind the internal condyle, the edge of the knife being kept close to the bone, and should then be held out of the way with a blunt hook or retractor. (Fig. 656.) In excisions for

Fig. 656.



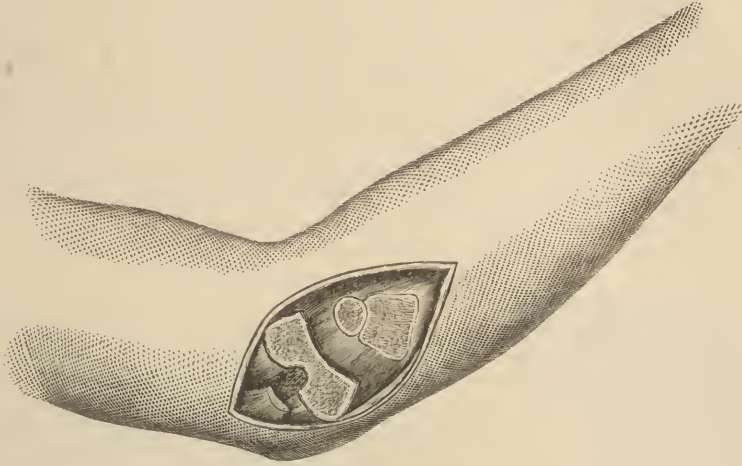
Excision of elbow-joint by single longitudinal incision.

chronic disease, there is no difficulty in avoiding the nerve, which is surrounded by thickened and infiltrated tissue, and, indeed, need not be seen during the whole operation; but in cases of primary excision for injury, the nerve is not thus protected, and then must be guarded in the way already described.

The back of the articulation having been exposed, the olecranon process is to be cleared, and may then be severed with strong-cutting pliers; while not at all essential, this procedure will be found to greatly facilitate the remaining steps of the operation. Bruns, and more recently Trendelenberg and Völker, recommend temporary resection of the olecranon, which they subsequently restore to its position, keeping it in place with a wire suture. With the object of preserving, as far as possible, the function of the triceps muscle, Prof. Spence advised that its tendon should be divided by an inverted A-shaped incision, and for the same purpose Dr. Hodges and the late Mr. Maunder directed that those fibres should be left uncut which were inserted into the fascia of the forearm. Prof. Sayre only removes the tip of the olecranon, leaving that portion to which the tendon is attached. Whatever plan be adopted, the joint is next forcibly flexed, and the forearm thrust backwards, the lateral ligaments being then carefully divided with the probe-pointed

knife. The operation is completed by removing the extremity of the humerus, just above the condyles, and the articulating ends of the radius and ulna, with Butcher's saw. The appearance of the wound after the bone-sections have been completed, is seen in Fig. 657. It is important, if possible, to

Fig. 657.



Excision of the elbow-joint; the operation completed.

retain the attachment of the biceps muscle, and therefore the tubercle of the radius should, unless itself diseased, be preserved, the bone being sawn through immediately below its head. Prof. Bigelow also preserves the external and internal condyles of the humerus, removing merely its articulating surface.

The operation having been completed, all bleeding vessels are secured with ligatures, the wound closed with sutures (after the introduction of a drainage-tube), and then lightly dressed, and the limb placed either upon an Esmarch's bracketed splint,¹ or, which I have found to answer every purpose, an ordinary, internal, angular splint, well padded and secured with bandages, so arranged that the wound can be uncovered for inspection without disturbing the whole apparatus.

It is desirable to keep the ends of the bones pretty well approximated until the external wound has united, and therefore an obtuse-angled splint (about 135°) answers a better purpose than one which is rectangular. On the other hand, in order to avoid ankylosis—much more to be dreaded in these cases than the so-called "flail-like" union, which, indeed, from what I have personally seen of the operation I should be disposed to look upon as a myth—the splint should not be worn longer than is necessary for the wound to become fairly consolidated, and I have, in children, advantageously dispensed with it as early as the eighth day after the operation. When the splint is removed, the patient may carry the arm in a sling, during the day, and have it laid upon a soft pillow at night.

I do not know that I can further illustrate the subject of elbow-joint excision better than by appending abstracts of a few cases which have been under my own care. I have resorted to this procedure in ten cases (one of these a partial excision) with four deaths, but one, or at most two, of which, can, however, be fairly attributed to the operation. In the following case death was probably hastened by the excision, but I believe would have followed with

¹ See Vol. II. page 164, Fig. 278.

equal certainty if no operation had been performed, and not improbably would have occurred at a still earlier period after amputation:—

Arthritis of Left Elbow in an Elderly Man; Excision; Death from Exhaustion on Thirty-third Day.—This case occurred in a man, B. F., fifty-six years of age, a native of this country, and a blacksmith by occupation, who entered the surgical wards of the Episcopal Hospital on January 26, 1867. He had been sent into the medical wards the day before, under the impression that he was suffering from rheumatism, and the true nature of his affection was not ascertained until the visit of the attending physician, Dr. James H. Hutchinson, upon the next morning. When I first saw the patient his condition was as follows: There was great swelling about the left elbow, and the joint evidently contained a considerable amount of fluid. There was not much pain about the part, and no grating perceptible upon motion of the articulation. The patient's general state of health was fairly good, though he was feeble and looked much older than most men of his age. This was accounted for by the fact that for some years before entering the hospital he had led a life of much hardship, and it was hoped that under more favorable circumstances an opportunity would yet be afforded for recovery through the efforts of nature alone. For nearly six weeks there seemed to be some improvement, with occasional relapses, but at the end of that time it became evident that the ligamentous structures of the joint were becoming rapidly disorganized, and distinct grating on rubbing together the opposing joint surfaces showed that the articular cartilages were undergoing absorption, while the patient's constitutional condition began to deteriorate coincidently with the progress of the local disease.

When it became manifest that the elbow-joint was hopelessly disorganized, it became a question whether the limb should be sacrificed, or whether an effort should be made for its preservation by resorting to excision. The latter mode of treatment was adopted on account of the limitation of the diseased action to the joint itself, and because, in the unfavorable general condition of the patient, it did not appear that an amputation would be much less hazardous than an excision.

The patient was accordingly brought under the influence of ether on March 20, 1867, and, the joint being fairly exposed by an **H**-incision, an inch of the lower extremity of the humerus, and an inch and a quarter of the ulna, with the head of the radius, were removed by means of a Butcher's saw, and a considerable amount of disorganized tissue clipped away from the floor and sides of the wound with the large knife-bladed forceps described by the same eminent surgeon. A good many ligatures were required to arrest the hemorrhage from small vessels which had been enlarged by inflammatory action, and, the edges of the wound having been brought together with points of the lead suture, the limb was placed in a well-fitting fracture-box and the patient restored to his bed.

The relief from pain after the operation was most marked, and for a week or ten days the progress of the case was as favorable as could be wished; but from this time, though with occasional improvement, the patient gradually failed, and death, which occurred on April 22d, seemed due to exhaustion and general diminution of vital power rather than to any positive complication or sequel of the operation. Though the soft parts had united to a considerable extent, there was no attempt at union between the ends of the resected bones, and an autopsy showed that there was slight ulceration of the mucous lining of the bladder, possibly following the use of the catheter, which it had been necessary to employ frequently during the last period of the patient's life.

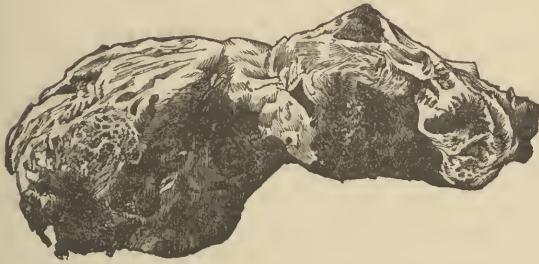
The next case was a more promising one for the operation, and doubtless would have terminated successfully but for the outbreak of tuberculous meningitis—an affection which, as every surgeon knows, is one of the causes of death which, in these chronic joint-affections, must always be taken into account in the matter of prognosis.

Excision of the Right Elbow-Joint for Disease in a Young Adult; Death from Tuberculous Meningitis.—This patient, J. D., a man twenty-five years of age, was admitted to the Episcopal Hospital on December 1, 1869, and first came under my care in January, 1870. The right elbow was the joint affected in this case, and the patient had been disabled by its condition for five or six months. The origin of the disease could not be ascertained, but the peculiar, globular shape of the part, the painless char-

acter of the swelling, and the degree to which passive motion could be carried, rendered it probable that the affection had begun in the synovial membrane and had thence spread to the ligamentous and cartilaginous structures, and that it was, in fact, an example of the condition described by Barwell as *strumous*, and by Athol Johnstone as *scrofulous synovitis*, and which I have myself ventured to call *gelatinous arthritis*.

No benefit having resulted from careful treatment by rest and moderate extension in the hands of the gentleman who had had charge of the case before it came under my care, and being fully satisfied that the disease had progressed too far to admit of recovery without operative interference, I determined to resort to excision, and accordingly, on January 27, 1870, the patient having been placed under the influence of ether, I opened the joint by a single longitudinal incision on its inner and posterior side, and, turning out the bones, removed with Butcher's saw their articulating extremities, taking a mere shaving from the head of the radius, which was not diseased. I then clipped away the disorganized soft tissues, closed the wound with the lead suture, and placed the arm at rest on a well-padded internal angular splint.

Fig. 658.



Lower end of humerus removed by excision of elbow.

Fig. 659.



Upper end of ulna removed by excision of elbow.

The accompanying illustrations (Figs. 658 and 659) show the condition of the articulating surfaces of the humerus and ulna. The articular cartilage has disappeared from the radial head (capitellum) of the former, and from the greater sigmoid cavity of the latter bone, and at these spots the osseous tissue is seen to be exposed and carious.

For several months after the operation the patient's condition was satisfactory, and there appeared to be every prospect of the case terminating successfully; but, during the month of May, he underwent a severe attack of traumatic erysipelas, and shortly after convalescing from this affection became wildly delirious, with fever, intense headache, screaming, and the presence of a well-marked *tache cérébrale*, and died on June 7, nearly nineteen weeks after the operation. A *post-mortem* examination showed, as was expected, that the cause of death was tuberculous meningitis.

In the following case the operation gave the patient a very useful arm, though ankylosis occurred as regards flexion and extension. Had the patient been more persevering in exercising the limb, or had I ventured, as I have in more recent cases, to abandon the splint at an earlier period, the result would doubtless have been still more satisfactory:—

Suppurative Arthritis of Right Elbow resulting from Injury; Excision; Recovery.—Josephine K., aged seven years, was admitted to the Children's Hospital on October 16, 1870, suffering from arthritis of the right elbow, the result of an injury received some six months previously. The joint was painful and tender, hot, and swollen, particularly at its radial side. After a fair trial of the effect of rest, with the administration of tonics and the topical use of soothing applications, excision was resolved upon, and on December 19, 1870, the patient having been etherized, the operation was performed, the joint being laid open by a single longitudinal incision, and the articulating

extremities of the several bones removed with the Butcher's saw. The joint was found to be full of pus, which gushed out as soon as the knife entered the articulation, the cartilages were eroded (especially over the head of the radius), and there was incipient caries of the subjacent bones. No ligatures were required, and, the edges of the wound having been brought together with leaden sutures, a strip of oiled lint was applied, and the limb placed at an angle of about 120° in a felt splint, which, however, bred maggots in the dressings, and was therefore replaced by a simple wooden splint on the third day. The after-progress of the patient was satisfactory; an abscess which formed in the neighborhood of the excision wound was opened on January 31, 1871; and in the following March the splint was left off, and a simple soap plaster and bandage substituted. The motions of pronation and supination were by this time fully restored, and there was slight power of flexion and extension, which could doubtless have been materially increased had the patient persevered in systematically exercising the limb. This, however, was not done, and ankylosis as regards flexion and extension eventually occurred. The patient was discharged from the hospital on April 15, 1872, but the last occasion upon which I saw her was in February, 1874, at which time the condition of the resected arm was very satisfactory, the limb though stiff being extremely useful, and the motions of pronation and supination being, as before remarked, perfectly restored.

The next case was also one of arthritis following injury, and, the splint having been dispensed with at an earlier period, the motions of flexion and extension were preserved, as well as those of pronation and supination.

Excision of Left Elbow-Joint for Arthritis; Recovery.—The patient in this case was a boy, R. A., aged ten years, a native of Scotland, who was admitted to the Episcopal Hospital on January 11, 1872, suffering from arthritis of the left elbow, the result of an injury received one year previously. Excision was performed in the usual way, the joint being opened by a single incision made in the direction of the long axis of the limb, on January 18. Five ligatures were required, the excision wound was dressed with oiled lint, and the arm placed on an internal angular splint. The excised parts presented a good example of ulceration of the articular cartilages with incipient disease of the underlying bone. The splint was left off in the course of a few weeks, and care taken to prevent the occurrence of ankylosis by the systematic use of passive motion. The result of the case was in every respect satisfactory, the patient leaving the hospital on June 1, 1872, with the wound firmly healed, and with the normal motions of the part quite restored.

In the next case I abandoned the use of the splint at a still earlier period:—

Excision of the Left Elbow-Joint in a Young Child; Splint left off after the Eighth Day; Recovery.—The subject of this case, G. P., a boy four years of age, entered the Children's Hospital on August 8, 1872, suffering from disease of the left elbow-joint of one year's duration, believed to have originated from an injury, though the history of this was not very clear. Excision was performed in the usual manner on August 12, two ligatures only being required, and the wound being closed with sutures, dressed with oiled lint, and placed on a splint; this, however, was dispensed with after the eighth day, by which time the wound had united and the parts were measurably consolidated, the limb from this time forward being simply supported in a broad sling. The condition of the excised parts may be seen from the accompanying illustrations (Figs. 660, 661); the principal seats of disease were the base of the trochlea and the greater sigmoid cavity of the ulna, at which points (*a, a*) the cartilage had disappeared and the subjacent bone was carious and deeply eroded. The progress of the case after the operation was satisfactory; an abscess which had formed in the neighborhood of the joint was opened on February 28, 1873, and the patient left the hospital on May 28, of the same year. A photograph, from which the annexed illustration (Fig. 662) has been copied, was taken in October, 1873, at which time the wound was firmly healed, the arm strong, and the motions of the part perfect in every respect.

In the next case the patient made a good recovery as far as the operation was concerned, but perished from the effects of constitutional disease nearly seventeen months subsequently.

Figs. 660, 661.



Parts removed in excision of the elbow.

Fig. 662.



Result of excision of elbow-joint.
(From a patient in the Children's Hospital.)

Excision of the Right Elbow-Joint for Destructive Disease, the Result of Hereditary Syphilis; Recovery; Death from Syphilitic Disease of the Brain, nearly a year and a half afterwards.—The patient in this case was one of those unfortunate children of whom we see so many in surgical practice among the poor of large cities, who enter upon life bearing about them the seeds of death, and who after a few years of suffering perish miserably, the victims of their parents' misconduct. J. S., a boy six years of age, entered the Children's Hospital on September 4, 1872, suffering from hereditary syphilis in an aggravated form. The record at the time of his admission shows that he had then necrosis of the left radius, and of the lower jaw, with severe osteitis of the right humerus, extending to the lower epiphysis of the bone and threatening the integrity of the elbow-joint. A day or two after admission, a superficial exfoliation was removed from the radius, and on September 9, the patient being etherized, a large sequestrum was taken from the jaw, the portion removed extending to the articulation of the left side, and constituting about one-third of the lower maxilla. Under careful nursing and constitutional treatment, the patient's general condition now improved, and the jaw and left arm healed; the state of the right arm, however, became steadily worse, and in January, 1873, it became evident that the elbow-joint was hopelessly diseased. Excision was accordingly resorted to on January 13, the operation being performed in the usual way, the wound dressed with oiled lint, and the limb laid upon a splint, which, however, was dispensed with as soon as the parts had become sufficiently consolidated. The progress of the case, as far as the operation was concerned, was satisfactory, the wound healing well and the patient regaining considerable use of the limb; but fresh evidences of constitutional syphilis were not slow to manifest themselves. Gummatous tumors, which rapidly ulcerated, formed on the arm, on the shoulder, and on the side of the chest; the *upper* jaw became necrosed, and in October about one-third of its alveolar border was removed; finally, in June, 1874, symptoms of cerebral disease were developed, the patient lying in a stupor unless roused, when he was delirious, but without excitement; and in spite of the administration of large doses of iodide of potassium, death preceded by coma took place on June 7. No *post-mortem* examination was permitted, but there can be little doubt that intra-cranial syphilis was the cause of the fatal issue.

The next case is illustrative of a condition perhaps more often met with in the knee than in the elbow, but which, when occurring in either situation, may, in children at least, be treated by excision with the most gratifying results.

Excision of the Left Elbow Joint for Partial Anchylosis with Recurrent Arthritis; Recovery.—This case occurred in a German boy, C. K., six years old, who was admit-

Fig. 663.



Result of excision of elbow-joint.
(From a patient in the Episcopal Hospital.)

tal cured, the photograph from which the annexed illustration (Fig. 663) is taken having been secured a few days before his departure.

In addition to the seven cases of which I have given the above brief abstracts, I have twice excised the elbow, in adults, for severe compound fracture into the joint, and once (a partial excision, involving only the olecranon and upper part of the ulna) for syphilitic necrosis (hereditary) in a child: this case ended favorably, the boy acquiring good motion in the joint, but both the traumatic cases were followed by death—in one from delirium tremens, and in the other from traumatic gangrene. The following table summarizes in a compendious manner the facts of the whole ten cases referred to.

TABLE OF TEN CASES OF EXCISION OF THE ELBOW.

No.	Sex and age.	Nature of affection for which operation was required.	Result; duration of treatment after operation.	Remarks.
1	Male, 56	Arthritis of left elbow	Died; 33 days	Death from exhaustion.
2	Male, 25	Gelatinous arthritis of right elbow	Died; 19 w'ks	Death from tuberculous meningitis.
3	Female, 7	Arthritis of right elbow from injury	Recovered; 16 months	Anchylrosis as to flexion and extension.
4	Male, 51	Compound fracture and dislocation of right elbow	Died; 7 days	Death from delirium tremens.
5	Male, 10	Arthritis of left elbow from injury	Recovered; 4½ months	Normal motions of part restored.
6	Male, 4	Arthritis of left elbow	Recovered; 9½ months	Normal motions restored.
7	Male, 6	Right elbow destroyed by hereditary syphilis	Recovered from operation	Utility of limb fairly restored; death from syphilitic disease of brain nearly a year and a half subsequently.
8	Male, 6	Partial fibrous anchylrosis of left elbow, with recurrent arthritis	Recovered; 7½ months	Normal motions of part restored.
9	Male, 38	Railroad crush of elbow	Died; 5 days	Death from traumatic gangrene.
10	Male, 10	Necrosis of ulna from hereditary syphilis	Recovered; 10 weeks	Normal motions preserved. (Partial excision.)

The circumstances which most influence the *results* of elbow-joint excision, are the age and constitutional condition of the patient, and the nature of the affection for which the operation is performed.

To show the effect exercised by the patient's *age*, I have compiled the following table from the figures given by Dr. Culbertson,¹ which, although the number of cases in which the age was not ascertained is too large to allow any very positive statements to be predicated upon them, yet illustrate the fact, familiar to practical surgeons, that, as in the case of most of the other joints, the most favorable age for excision is that of childhood and early youth, and that after the period of puberty the mortality steadily increases with advancing years.

TABLE SHOWING RESULTS OF EXCISION OF THE ELBOW AT DIFFERENT AGES.

Age.	Total.	Recovered.	Died.	Result undetermined.	Mortality per cent. of terminated cases.
Under 5 years	12	10	2	...	16.7
Between 5 and 10 years	29	24	3	2	11.1
" 10 " 15 " 	55	50	4	1	7.4
" 15 " 20 " 	69	59	6	4	9.2
" 20 " 25 " 	85	71	11	3	13.4
" 25 " 30 " 	58	47	10	1	17.5
" 30 " 40 " 	62	49	11	2	18.3
Over 40 years	49	36	11	2	23.4
Age not stated	656	535	106	15	16.5
Aggregates	1075	881	164	30	15.7

The *constitutional condition* of the patient exercises a very important influence on the result of the operation. There is no doubt less immediate risk attending an excision of the elbow than an amputation of the arm, on account of the comparative freedom from hemorrhage in the case of the first-named operation; but the much longer period required for convalescence, after excision, not only exposes the patient necessarily during a longer time to the inroads of what are often, though improperly, called hospital diseases (erysipelas, pyæmia, etc.), but gives opportunity for the development of visceral diseases, especially tuberculous and amyloid degeneration, or for their aggravation if already in existence.

Hence, before determining to resort to excision of the elbow, particularly in the case of an adult, the surgeon should carefully inquire into the patient's constitutional condition, and especially into the state of the lungs, liver, and kidneys; should there be reason to suspect serious disease of any of these organs, the operation of excision would be so far contra-indicated, and, if under these circumstances any interference should be required, preference should as a rule be given to amputation.

The influence exercised upon the result of elbow-joint excision by the *nature of the affection* for which the operation is required, is clearly shown by the following table, compiled from Dr. Culbertson's² figures, supplemented by those of Prof. Gurlt,³ in respect to gunshot injuries:—

¹ Op. cit., p. 482.² Op. cit., p. 488.³ See Table on page 558.

TABLE SHOWING RESULTS OF EXCISION OF THE ELBOW FOR INJURY AND FOR DISEASE OR DEFORMITY.

Nature of case.	Total.	Recovered.	Died.	Result unde- termined.	Mortality per cent. of terminated cases.
Gunshot wound	1309	987	322	...	24.6
Other injury	70	56	10	4	15.1
Disease or deformity	407	346	41	20	10.6
Aggregates	1786	1389	373	24	21.2

There still remain to be considered the comparative advantages of *partial* and of *complete excision*, and the value of the preserved limb or the *end-result* of the operation.

Partial excision (in military surgery) is preferred by Dominik, and his view is favored by Hueter, Langenbeck, and Gurlt, but, as far as the statistics of the late American war are concerned, the advantage is with the more sweeping operation. I am disposed, however, to acquiesce in the justice of Dr. Otis's suggestion, that in traumatic cases, and, I may add, in some cases of necrosis—provided that the joint be fully exposed and free drainage secured—it may be sufficient to cut away the parts actually injured or diseased. In ankylosis, also, it may suffice to excise merely the lower part of the humerus, as advised by P. H. Watson and Annandale. But in all cases of chronic disease of the articulation, and certainly in most cases of gunshot injury, *complete excision* may be expected to give the best results. The following table, compiled from the statistics collected by Dr. Otis¹ and Dr. Culbertson,² gives the figures bearing upon this subject:—

TABLE SHOWING RESULTS OF PARTIAL AND OF COMPLETE EXCISION OF THE ELBOW.

Nature of case.	Partial.			Complete.			Not Stated.			Total.		
	Recov- ered.	Died.	Mortal. per ct.	Recov- ered.	Died.	Mortal. per ct.	Recov- ered.	Died.	Mortal. per ct.	Recov- ered.	Died.	Mortal. per ct.
Gunshot wound	294	84	22.2	93	21	18.4	83	41	33.1	470	146	23.7
Other injury . .	25	2	7.4	30	8	21.1	1	...	.....	56	10	15.1
Dis. or deformity	45	5	10.0	295	32	9.8	6	4	40.0	346	41	10.6
Aggregates .	364	91	20.0	418	61	12.7	90	45	33.3	872	197	18.4

The *utility of the preserved limb*, after excision of the elbow, is in most cases very great. As already mentioned, there is much more risk of ankylosis than of excessive mobility, and this is one reason for preferring, in most cases, complete to partial excision. Indeed, it may be said that, within reasonable limits, the more bone that is removed, the better is the result likely to prove. Prof. Ollier lays great stress upon the importance of preserving the periosteum in elbow-joint excisions, with a view of obtaining reproduction of the articular extremities, and consequent restoration of function; but in many cases operated upon in the ordinary way, the limb becomes in the course of time so useful as to leave nothing to be desired in this respect. Ollier reports 36 cases operated on by the sub-periosteal method, with only 5 deaths; and in a later communication³ brings up the number to 48 cases, with not a single

¹ Op. cit., Second Surgical Volume, p. 894.

² Op. cit., p. 492.

³ Des Résections et des Amputations chez les Tuberculeux, p. 7. Paris, 1883.

death due to the operation itself. The "end-results" of the operation in military practice, as shown by the table on page 584, from Gurlt, are upon the whole satisfactory, the proportion of good results being nearly one in three, of medium results more than one in two, and of really bad results only about one in six. In civil surgery, the results are even more gratifying, Dr. Hodges's tables showing that 77 out of 89 patients who recovered, had useful limbs, and those of Drs. Heyfelder and Bœckel, giving the figures as 94 out of 118.

EXCISIONS OF THE RADIUS AND ULNA.—Excision of the bones of the forearm, one or both, partial or complete, may be required in cases of caries or necrosis, certain forms of tumor, and compound or ununited fracture. Of the more extensive operations of this kind, the earliest of which I have any knowledge was that of Dr. R. B. Butt, of Virginia, who, in 1825, resected the lower two-thirds of the ulna on account of caries, the patient recovering with a useful limb. A similar operation, involving the removal of almost the whole radius, in a case of necrosis, was performed at the Pennsylvania Hospital by Dr. J. Rhea Barton, of Philadelphia, in 1828. This case appears never to have been published until a few months ago, when Dr. W. Barton Hopkins, a kinsman of the distinguished operator, came across the patient in the out-door service of the Episcopal Hospital, and subsequently exhibited her at a meeting of the Philadelphia College of Physicians.¹ Dr. Hopkins had an engraving made to show the appearance of the limb, and has kindly given me an electrottype of the same. (Fig. 664.) In spite of the marked deformity in this case, the patient had regained almost perfect use of her arm.

Still more extensive excisions in this locality have been done by Compton, of New Orleans, who, in 1853, removed the whole ulna and greater part of the radius; by Williamson, who excised the entire ulna and the elbow-joint; and by Erichsen, who excised the elbow-joint with the greater part of the radius. Complete excision of the ulna has been practised by Carnochan, of New York; Jones, of Jersey; Joseph Bell, of Edinburgh; Hutchison, of Brooklyn; and W. M. Fuqua, of Hopkinsville; while complete excision of the radius has also been resorted to by Carnochan, and by C. C. Field, of Easton, Pa.

The operation, in the case of the radius, requires a longitudinal incision of sufficient length, on the outer and posterior aspect of the forearm, the bone being then bisected with the chain-saw, and either portion dissected out separately (Fig. 665). In cases of necrosis, an attempt should be made to preserve the periosteum. For excision of the ulna, a similar operation is required, but the wound is, of course made on the inner instead of the outer side of the limb.

Fig. 664.

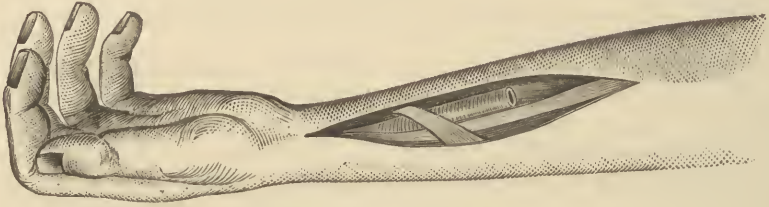


Deformity following excision of the radius.

¹ Trans. Coll. Phys. Phila., 3d S. vol. vi. p. 371.

My personal experience of these operations is limited to partial excisions, twice of considerable portions of the radius, in cases of gunshot fracture (one a primary and one a secondary operation), and once of the same bone in a

Fig. 665.



Excision of the radius.

case of ununited fracture, in which, after resecting the bone, I secured the fragments together with wire sutures, after the manner of Prof. Ollier and Prof. Bigelow.

Fig. 666.



Result of partial excision of the radius. (From a patient in the Episcopal Hospital.)

were successful, though in both the cases of gunshot fracture the patients went through sharp attacks of pyæmia before recovering. The appearance of the limb in the case of primary resection is shown in the accompanying illustration. (Fig. 666.)

The results in these cases are usually quite satisfactory as regards the life of the patient, and even as regards utility of the preserved limb, though if any considerable portion be removed from either bone alone, there is apt to be marked deformity with deflection of the hand toward the affected side. Even in cases of myeloid tumor of the bones, which are usually considered to require amputation, success, as has already been mentioned, has followed excision in the hands of Mr. Lucas and Mr. Morris. The following table, compiled from the statistics furnished by Drs Otis and Huntington,¹ shows that the mortality of the operation in military practice is

very small—considerably less than that which attends amputation of the forearm; so that in favorable cases, and particularly when one bone only is involved, and when the laceration of the soft parts is not extensive, the operation may be properly resorted to. Heyfelder tabulates 39 cases, derived mainly from the records of civil life, without a single death, and with 34 more or less perfect successes as regards the restoration of function.

¹ Op. cit., Third Surgical Volume, page 875.

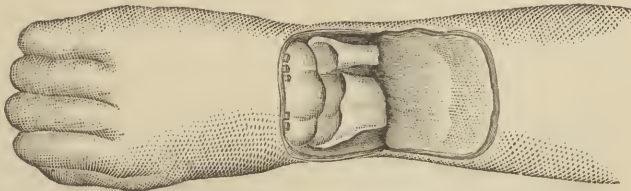
TABLE SHOWING RESULTS OF EXCISIONS IN SHAFTS OF RADIUS AND ULNA FOR GUNSHOT INJURY.

Period of operation.	Total.	Recovered.	Died.	Undetermined.	Mortality per cent.
Primary	665	589	71	5	10.7
Intermediate	149	120	29	...	19.4
Secondary	40	36	4	...	10.0
Unknown	132	111	5	16	4.3
Aggregates	986	856	109	21	11.3

EXCISION OF THE WRIST-JOINT.—Judging from my own experience, I should say that wrist-joint excision was an operation the indications for which were seldom met with; at least, I have never seen a case in my own practice in which I have felt it right to resort to this operation, those cases, whether of injury or of disease of the wrist, which have been bad enough to require any operation, having been so bad as to make me think amputation a safer remedy. The fact is, that there is no joint in the body in which more can be done by careful and long-continued, expectant treatment than in the wrist; the part can be kept quite at rest on a splint, while the patient goes about and pursues his ordinary avocations, and unless some complication, such as grave visceral disease, intervenes to prejudice the prospects of recovery, an ultimate cure can almost certainly be prognosticated. I have more than once seen wrists in which the carpal bones seemed to be completely separated from each other, rattling about like beans in a bag, and in which, nevertheless, recovery with a useful hand was eventually obtained. At the same time, I doubt not that cases do occur in which operative interference is imperative, and in which excision should be preferred to amputation.

The lower end of the radius was successfully excised by Cooper, of Bungay, in 1758, but the first operation which deserves to be termed an excision of the wrist-joint appears to have been performed by the elder Moreau, in 1794. Various forms of operation have been adopted for wrist-joint excision, those which afford the most complete exposure of the articulation being probably the H-shaped incision, and the dorsal flap method of Velpeau, shown in Fig. 667. No large vessels are cut by this incision, but even if the extensor ten-

Fig. 667.

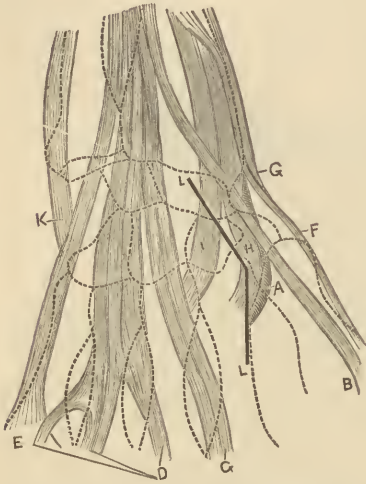


Excision of wrist by flap method.

dons of the fingers are not divided, as they usually must be, they will necessarily be more or less bruised and lacerated, and will be so matted together by the subsequent inflammation that the utility of the hand will be considerably impaired. Hence, by the general consent of surgeons, the modification of Dubled's operation introduced by Prof. Lister, is now preferred to any other.

This procedure, the advantages of which can be best understood by a reference to the annexed diagram (Fig. 668), requires two incisions, one on the radial and one on the ulnar side of the joint.

Fig. 668.



Excision of wrist by Lister's method.—A. Radial artery. B. Tendon of extensor secundi internodii pollicis. C. Indicator. D. Extensor communis digitorum. E. Extensor minimi digiti. F. Extensor primi internodii pollicis. G. Extensor ossis metacarpi pollicis. H. Extensor carpi radialis longior. I. Extensor carpi radialis brevior. K. Extensor carpi ulnaris. L L. Line of radial incision. (After Lister.)

when the anterior ligaments of the joint are divided, and the cutting pliers then introduced, first between the carpus and radius, and afterwards between the carpus and metacarpus. Its connections having been thus severed, the entire carpus, with the exception of the trapezium and pisiform bones, can be pulled out with a strong pair of forceps. The articulating extremities of the radius and ulna are next made to protrude through the ulnar incision, and as much sawn off as may seem necessary; the ulna should be sawn obliquely so as to leave the styloid process, the retention of which serves to diminish the tendency to subsequent displacement. The articulating ends of the metacarpal bones are next brought out and resected, and the operation is then finished by carefully dissecting out the trapezium, and by removing the articulating surface of the thumb, and as much of the pisiform and hook-like process of the unciform as may be thought desirable. Free drainage must be secured by leaving the ulnar wound partly open, or by the introduction of drainage-tubes, and the hand may then be placed upon such a splint as is shown in Fig. 588 (page 400), or, which would probably answer as well, an ordinary Bond's splint.

Mr. Butcher, and more recently Mr. W. R. Williams, have urged very strongly that the trapezium should be preserved in this operation, believing that the future utility of the thumb depends greatly upon its retention; the last-named surgeon has found, as did Sir W. Fergusson, that it is feasible to remove the carpus through a single longitudinal incision, on the ulnar side.

Partial excisions of the carpus have been practised, but, I think, have not usually proved very satisfactory; in a good many instances, destructive in-

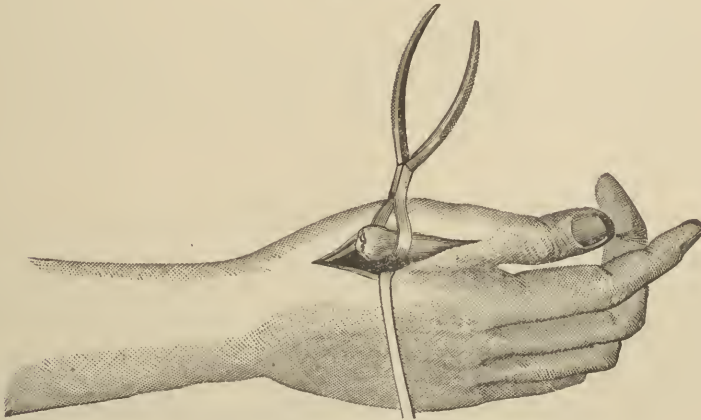
The *radial incision* begins about the middle of the dorsal aspect of the radius, on a level with the styloid process, and extends downwards and outwards toward the inner side of the metacarpo-phalangeal articulation of the thumb, but, on reaching the line of the radial border of the metacarpal bone of the index finger, diverges at an obtuse angle and passes longitudinally downwards for half the length of that bone. The *ulnar incision* begins two inches above the end of the ulna, and immediately in front of it, extends downwards between the ulna and the flexor carpi ulnaris, and ends at the middle of the palmar aspect of the fifth metacarpal. The only tendons necessarily severed in this operation are the extensors of the carpus itself. The trapezium is to be separated from the other carpal bones by cutting with the bone-forceps before the ulnar incision is made, but is not to be removed until a later stage of the operation; in like manner, the pisiform bone is to be separated and left attached to the flexor carpi ulnaris, while the hook of the unciform bone is also cut through and left attached to the annular ligament. The tendons are next raised both in front of and behind the wrist,

flammation has spread to other parts of the wrist, necessitating amputation, and when this has not occurred ankylosis has commonly followed, impairing of course the usefulness of the limb.

The statistics of wrist-joint excision are quite favorable as regards the life of the patient: of 119 cases in military surgery analyzed by Prof. Gurlt,¹ only 19 proved fatal, a mortality of less than 16 per cent., while 85 terminated cases of excision for disease, tabulated by Dr. Culbertson,² gave but 10 deaths, a mortality of less than 12 per cent. Sixteen cases of excision for injury other than gunshot wound, collected by the same author, gave only two deaths, a mortality of 12.5 per cent. On the other hand, subsequent amputation was required in 10 cases of excision for disease, in Dr. Culbertson's tables; in 11 the preserved hand was "not useful;" and in 16 more the result as regards utility was uncertain—thus reducing the number of certainly successful operations to 42, or less than one half. Gurlt's figures also, as given in the table on page 470, show that after operations for gunshot injury the preserved limb has usually been anything but satisfactory, the cases therein recorded having given seven "bad" results, eight "medium" results, and only one "good" result among the whole sixteen. Hence, while the operation may be properly resorted to in selected cases—and particularly in favorable cases of compound fracture and dislocation in civil life—it cannot be said that the wrist is a locality in which the advantages of excision are conspicuous.

EXCISIONS IN THE HAND.—The *metacarpal bones* may require excision on account of gunshot fracture, tumor, or necrosis. Compound fractures resulting from injuries other than gunshot wounds, usually, if any operation is demanded, require amputation. A single longitudinal incision on the back of the hand suffices to expose one of the metacarpals; precautions must be taken not to injure the extensor tendon, which should be carefully held to one side. If a partial excision is to be practised, the bone may be divided

Fig. 669.



Excision of metacarpal bone of thumb.

with cutting pliers, but for a complete excision, disarticulation from the phalanx should be first effected, and the bone then held up with Fergusson's forceps while it is separated from its palmar and carpal attachments. In cases of necrosis, an effort should be made to preserve the periosteum. When

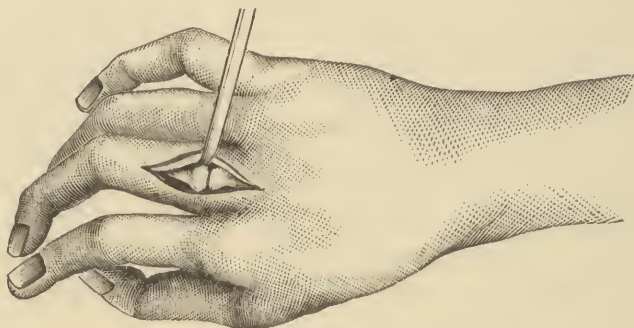
¹ See table on page 558.

² Op. cit., page 624.

the metacarpal bone of the thumb is the part to be removed, disarticulation may be first effected at either end, as may be found most convenient. (Fig. 669.)

Excision of a *metacarpo-phalangeal joint*, which may be required either for compound fracture or dislocation, or for disorganizing disease, may also be satisfactorily accomplished through a longitudinal, dorsal incision, the tendon being held out of the way, and the bones divided, either before or after disarticulation, with cutting forceps. (Fig. 670.) For excision of the *interpha-*

Fig. 670.



Excision of metacarpo-phalangeal joint.

langeal joints, a similar operation may be practised, but in this locality the longitudinal incision should be made on one or other side, instead of on the dorsal surface.

These operations commonly result favorably as regards the life of the patient, 114 terminated cases of resection of the bones of the hand for gunshot injury, tabulated by Drs. Otis and Huntington,¹ having given 11 deaths, a mortality of less than 10 per cent. But a finger that has lost its metacarpal bone or metacarpo-phalangeal joint, commonly becomes distorted and shortened, and not only is the symmetry of the hand lost, but its functions are more or less seriously interfered with.

Metacarpal excisions may be sometimes required in connection with partial amputations of the hand, but no general rules can be given for their performance under such circumstances.²

EXCISIONS IN THE LOWER EXTREMITY.

EXCISION OF THE HIP-JOINT.—This operation may be required in cases of injury (especially from gunshot wound), or of hip-disease, and possibly in some cases of necrosis of the upper part of the femur, though in that affection it would usually be right to wait for the spontaneous separation of the dead portion, which could then be removed with comparatively little risk. Excision of the hip has also been performed in cases of malignant disease, of ankylosis, and of rheumatoid arthritis. If ankylosis in a bad position be accompanied, as it sometimes is, by extensive caries, the operation may be properly resorted to as a means of relieving both conditions, but under other circumstances subcutaneous osteotomy, by Mr. Adams's or Mr. Gant's method, would be preferable, as promising an almost equally good result, and as being attended with very much less danger. For the other conditions

¹ Op. cit., Third Surgical Volume, page 875.

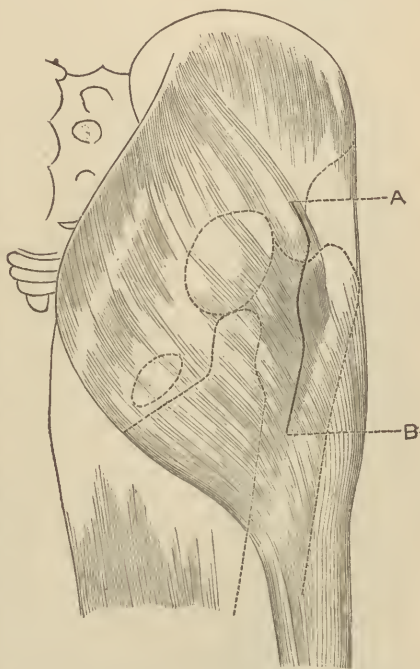
² See Vol. I., pages 640 *et seq.*

named, hip-joint excision seems to me an unsuitable operation. Dr. J. W. Howe, of New York, has recorded a successful excision of the hip for ununited fracture.

The first suggestion of hip-joint excision was made by Charles White, of Manchester, in 1769, but the operation was not actually performed until many years afterward, by Anthony White, of London, in 1822. The case recorded by Schlichting, in 1730, often spoken of as an excision, was a simple extraction of the caput femoris through a dilated sinus, and Schmalz's case, in 1816, was of the same character. Anthony White's case was one of deformity following the spontaneous cure of hip-disease, and a simple osteotomy would have been better than excision, which was, however, quite successful. The fatal operation attributed to Hewson, of Dublin, in 1823, appears to have been of the same character. The first excision for gunshot injury was performed by Oppenheim, in 1829; the first excision for necrosis by the elder Textor, in 1834; and the first excision for hip-disease by Sir Benjamin C. Brodie, in 1836. The operation was introduced in France by M. Roux, in 1847, and in this country by Prof. Bigelow, of Boston, in 1852. The first successful hip-excision in military practice was performed during the Crimean War by Surgeon O'Leary, in 1855.

Various incisions may be adopted for this operation: The single longitudinal, the curvilinear, the crucial, and the T-shaped incisions, all have their advocates, but, upon the whole, I am disposed to give the preference to that recommended by O. Heyfelder, the peculiarities of which can be seen from the annexed illustration. (Fig. 671.) The wound begins a little above and behind the great trochanter, towards which it passes in the line of the fibres of the gluteus maximus muscle, and then, curving around and behind the trochanter, extends downwards and a little backwards, terminating over the linea aspera between the insertions of the gluteus and the vastus externus. By this incision, two irregular flaps are formed, the loosening of which affords abundant room for the future steps of the operation, while it entails no transverse division of muscular fibres. If spontaneous dislocation have already occurred, the head of the bone may now probably be at once protruded through the wound, but under other circumstances, the capsule of the joint must be opened, and the ligamentous structures cautiously divided with the probe-pointed knife; in cases of hip-disease, the ligamentum teres will have usually disappeared, but in traumatic cases it must be severed before the caput femoris can be protruded. The head and neck of the bone being free, the femur is to be rotated first in one direction and then in the other, while the muscles attached to the trochanters are shaved off close to their insertions, and the limb is then forcibly adducted and pushed upwards, so as to make its upper extremity project through the wound, when it is cut through with the chain-saw just below the great trochanter. (Fig. 672.)

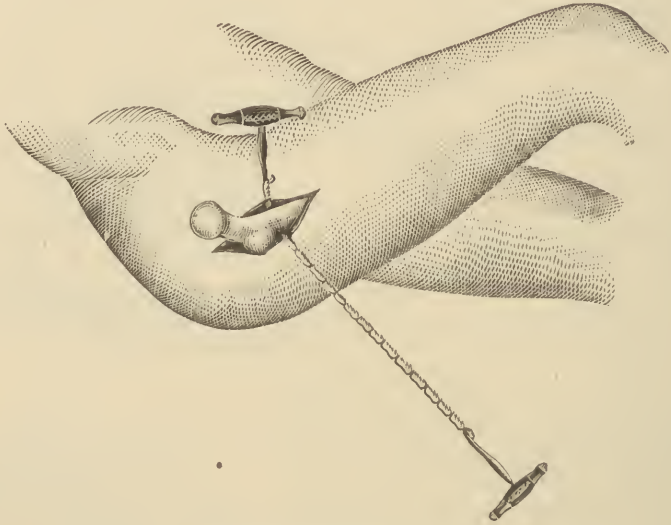
Fig. 671.



Heyfelder's incision for excision of the hip-joint.

Prof. Sayre, who lays great stress upon the importance of a sub-periosteal excision, divides the periosteum transversely with a strong-bladed knife, somewhat like an "oyster-knife," separates the membrane with an elevator, and saws through the bone *in situ* with a straight saw, before disarticulating; but my own experience leads me to think, with Mr. Holmes, that the sub-

Fig. 672.



Excision of the hip-joint.

periosteal method presents no particular advantages in this situation, and I believe that it is safer to effect disarticulation before applying the saw, in the way above described. In some cases, however, where there is firm ankylosis, this cannot be accomplished, and it may then be necessary to use the straight saw, and afterwards clear away the head and neck of the femur from the acetabulum with gouge and mallet.

The great trochanter should, I think, always be removed, even if it be not itself diseased, as it is apt to become so subsequently, and may interfere with the healing of the wound by protruding between its lips. The lesser trochanter may also be cut away with bone forceps, if it seem very prominent, and it is well to trim the edges of the truncated shaft so as to round it off, and give it somewhat the form of the natural head of the femur. Care must be taken, in pushing up the caput femoris through the wound, not to fracture the shaft; this accident, which has occurred twice within my own knowledge, does no particular harm, as the bone reunites without difficulty, but it adds an inconvenient complication to the after-treatment.

The femur having been resected, the acetabulum and other exposed portions of the os innominatum are to be carefully examined, and any portions that are found carious or necrosed freely dealt with, loose fragments being extracted, and parts that are diseased but not loose removed with gouge or gouge-forceps, osteotrite, trephine, or small saw. Surgeons formerly thought that interference with the pelvic bones was unjustifiable, and that extensive pelvic disease therefore forbade the hope of successful excision; but Hancock, Erichsen, and others have shown that the acetabular form of hip-disease is almost as amenable to operative treatment as the femoral, and the whole bony floor of the acetabulum, and even large portions of the ischium and

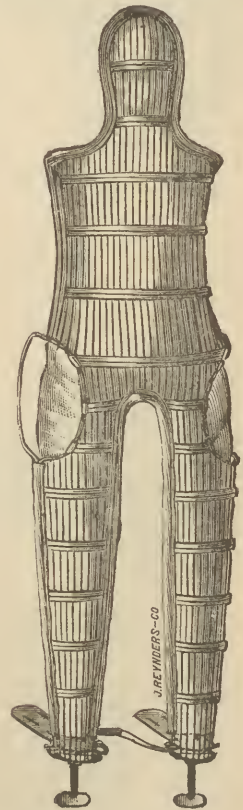
pubis, have, accordingly, been safely removed. As pointed out by Mr. Hancock, there is no danger that the pelvic cavity may be opened in these operations, since its inner wall, formed of muscles and fasciæ which are thickened and infiltrated with lymph, constitutes an efficient barrier to forbid the possibility of such an event.

The after-treatment of hip-joint excision is a very simple affair; free drainage must be provided for the wound, which should be closed with a few sutures and lightly dressed with oiled lint, covered with oiled silk, and the patient should be kept in bed for a few weeks, with the limb well abducted, so as to obviate any tendency to protrusion of the sawn end of the femur. Moderate extension should be made by means of a weight—from two to ten pounds, according to the age of the patient—which may be adjusted with the ordinary adhesive-plaster stirrup, employed in cases of fractured thigh, while lateral support is afforded by the apposition of sand-bags which should be covered with India-rubber cloth to prevent their becoming soiled by the discharges. The plan which I adopt is to place a bunch of oakum outside of the immediate dressing of the wound, and then put under the patient's hips and thigh a folded sheet or "slip-sheet," which is brought up between the patient's side and the outer sand-bag, so as to prevent the latter from coming in immediate contact with the limb. When the dressings are to be renewed, the weight is raised and the sand-bags are carefully lifted away, and while one assistant keeps up the extension, another gently rolls the patient on his sound side, when the wound can be cleansed and the fresh dressings adjusted with a minimum of disturbance. Prof. Sayre places the patient, immediately after the operation, in a somewhat formidable-looking wire "cuirass" (Fig. 673) modelled upon Bonnet's apparatus, which is padded to prevent excoriation, and provided with screws for making extension; but the simple appliances which I have described are so satisfactory that I have never felt disposed to employ any other.

As soon as the wound is sufficiently consolidated—usually in six or eight weeks—the patient should be allowed to sit up, and then to get about with crutches, or with one of the ingenious splints which have been devised for the treatment of hip-disease, and several of which have been figured in Mr. Barwell's article on Diseases of the Joints.¹

The surgeon should not hastily abandon the hope of success, even if the wound do not unite promptly, and though suppuration continue profuse. Unless there be serious visceral disease at the time of, or developed subsequent to, the operation, careful dressing and judicious constitutional and hygienic treatment will almost always suffice to bring about ultimate recovery. *Re-excision* has occasionally been practised with advantage in these cases, and if the patient's powers of recuperation seem to be failing, the question of *amputation* may be properly entertained. As may be seen by the table on page 616, that operation has under such circumstances resulted favorably in at least seventeen out of thirty-one cases in which it has been resorted to.

Fig. 673.



Sayre's "cuirass," for after-treatment of cases of hip-joint excision.

¹ See Figs. 620-624, pp. 509-511.

As was done in the case of the elbow, I shall further illustrate the subject of hip-joint excision by appending brief abstracts of a few cases selected from those in which I have myself had occasion to employ this mode of treatment.

The following case is of some local historical interest, as having been the second in which excision of the hip-joint had ever been done in Philadelphia, and the first which terminated successfully. Dr. Addinell Hewson was the pioneer in this procedure, in Philadelphia, having, in 1858, excised the left hip, in a girl of thirteen, at the Wills Hospital for the Blind and Lamé; this case ended unfavorably, the patient sinking, exhausted by diarrhœa, seven months after the operation. No further attempt was made in this city to excise the hip-joint until I did it at the Episcopal Hospital, nine years subsequently.

Excision of the Hip for Acute Hip-Disease with Abscess; Recovery with perfect Use of Limb.—W. E., aged four and a half years, was admitted to the children's ward of

the Episcopal Hospital on June 15, 1866, suffering from hip-joint disease of the right side, of recent origin. I found him in the ward at the beginning of my term of service, in the month of January, 1867. On January 5, I find an entry in my note-book, that a large abscess was forming in connection with the joint. This abscess opened spontaneously ten days afterwards, and from that time the patient's health rapidly deteriorated. On February 27, 1867, with the assent and assistance of my colleagues, I excised the head and neck of the right femur, making the section a short distance below the trochanters, and removing in all about two and a half inches of bone. The incision employed was that recommended by O. Heyfelder (see Fig. 671), and the bone was divided partly with a chain-saw and partly with strong cutting forceps, the head of the bone separating from the neck in the process of removal, and the great trochanter, too, remaining adherent to the lower flap from which it was afterwards carefully dissected. The appearance of the excised portions of bone, which are now in the Hospital Museum, are shown in the annexed wood-cut. (Fig. 674.) The operation was greatly facilitated by the fact that dislocation had already occurred, the head of the femur being found displaced from the acetabulum to the dorsum ilii. The acetabulum itself presented very little evidence of disease, and was therefore not interfered with. Two ligatures only were required.

The patient's convalescence, though slow, was upon the whole satisfactory. His condition gradually improved, the greater part of the wound healing by adhesion, and his health and strength being little by little restored. One or two abscesses formed around the seat of operation, and were opened, and in the following summer the patient suffered a good deal from diarrhœa; but in spite of these complications a progressive amendment was observed in the child's state, both constitutional and local, and by January of the next year (1868) his recovery could be considered as established. His condition, thirteen months after the operation, was as follows: There were still several sinuses, which could not, however, be ascertained to communicate with diseased bone, and which, together, discharged on an average less than a fluidrachm of pus in the course of twenty-four hours. The patient could support a

Fig. 674.



Head and neck of femur removed by excision.

Fig. 675.



Result of hip-joint excision.

great deal of his weight on the affected limb, and could walk with one crutch, or the hand of an attendant. The power of flexion and extension of the limb was to a considerable degree restored, and the shortening of the thigh, by measurement, was but an inch and a half, although the amount of bone removed was quite two and a half inches in length. The child, six years old, was fat and hearty, and entirely free from all pain and suffering. He left the hospital on April 3, 1868.

I have seen this patient since, at long intervals, and about four years after the operation obtained the photograph from which the annexed wood-cut is taken. (Fig. 675.) His sinuses were then all soundly healed, and he walked briskly without assistance from my office to the photographer's. The last visit that I have had from him was about three years since—between thirteen and fourteen years, therefore, after the operation—when he told me that he was earning a livelihood as an operative in a mill, was in excellent health, and, except that he knew that one leg was shorter than the other, felt no difference between them; he engaged in all the active amusements and sports of his fellows, and, to use his own expression, could “walk with any one, run with any one, skate with any one, and swim with any one.”

In the next case, although the patient was benefited, and his life probably prolonged, by the operation, the ultimate result of the case was unfavorable, the patient dying from tuberculous disease nearly a year after the date of excision:—

Excision for Hip-Disease of two years' standing; Recovery from Operation; Death from Visceral Disease more than eleven months subsequently.—T. M., aged nine years, came under my care at the Children's Hospital in the autumn of 1870. He was suffering from hip-disease of the left side, the malady having reached the third stage, and two sinuses, which communicated with the joint, discharging, one on the anterior and the other on the posterior surface of the thigh. The duration of the disease had been two years, and that of the abscess eighteen months. The patient's health was failing. On October 14, 1870, I removed the upper extremity of the femur by Heyfelder's incision, dividing the bone just below the trochanter with a chain-saw, and then gouged the carious rim of the acetabulum, which was the only part of the pelvis affected. The head of the femur had almost wholly disappeared, and the long-continued inflammatory action had caused a marked change in the direction of the neck of the bone. (Fig. 676.) No ligatures were needed; the wound was dressed with oiled lint, and the weight and sand-bags applied in the manner already described. Convalescence was slow, but by January, 1871, the patient was walking with crutches, and a month afterwards with a single crutch and high-soled shoe. Everything went well until the next June, when the patient was attacked with diarrhœa of an exhausting character. In August, he was removed from the hospital by his parents, contrary to advice, and was evidently neglected by them in a shameful manner, for he was brought back the next month in a most deplorable condition, with the wound reopened and the bone protruding. He died September, 27, 1871, and an autopsy showed, besides some roughness of the os innominatum, tubercle in both lungs and in the right kidney, with fatty and amyloid degeneration of the liver.

Fig. 676.



Bone removed in hip-joint excision, showing change in cervix femoris.

In the following case, while the local condition was that of advanced hip-disease, there was no visceral complication, and the result of the operation was everything that could be wished for:—

Excision of Hip for Coxalgia of nearly two years standing; Recovery with perfect Use of Limb.—A. H., aged fourteen, was admitted under my care, at the Children's Hospital, on September 15, 1875. He was suffering from hip-disease of the left side,

of twenty months' duration, several sinuses opening on the outer, and one on the inner side of the thigh; there was partial ankylosis, the limb being very much shortened and everted; the patient had been unable to walk from the beginning of his malady, and yet was in fairly good general health. On September 23, I operated by Heyfelder's method, finding the head of the bone spontaneously separated, and a considerable formation of new bone from the periosteum around the neck. The femoral medulla was very soft and diffuent, but red—not purulent. The bone-section was made below the trochanters, the periosteum being preserved, and then the edge of the acetabulum, which was carious, was freely gouged and scraped. No ligatures were required, but there was rather free capillary oozing, which continued in slight amount through the next day. There was a moderate degree of traumatic fever, the thermometer on the evening of the second day marking 102° Fahr. The wound united solidly by adhesion almost throughout its entire length, and convalescence proceeded rapidly. In three weeks, the patient could draw up his limb by his own efforts, and in two months from the day of operation began to walk with crutches. On February 1, 1876, I find a note that he could walk with one cane, and on March 1, that he could walk a little without a cane, wearing a high-soled shoe. In June he was sent to the Children's Sea-shore House, at Atlantic City, whence he returned in August, walking readily without any assistance, and with the wound and all sinuses healed except at one point. The photograph from which Fig. 677 is copied, was taken September 13, 1876, ten days less than a year from the date of excision.



In the following case, as in that of T. M., the patient may be said to have recovered from the operation, only to die some months later from visceral disease:—

Excision for Hip-Disease of long standing; Recovery from Operation; Subsequent Death from Visceral Complications.—R. S., a young Irishman, twenty years of age, a cabinet-maker by trade, was admitted to the Episcopal Hospital on January 3, 1876, suffering from hip-disease of between four and five years' duration. For two years he had been incapacitated from work, but fibrous ankylosis in a good position was occurring, when an over-zealous surgeon in another hospital thought to restore motion to the part by breaking up the existing adhesions. This attempt was productive of no benefit whatever, but on the contrary, resulted in the formation of a large abscess, which opened

spontaneously a few days after the patient came under my care. For several weeks, under careful treatment, there seemed to be some improvement, but this did not continue, and the patient then failed so rapidly that by the middle of March it was evident that unless the disease could be arrested by an operation, the case would ere long terminate fatally. On March 15, therefore, I excised the hip in the usual way, and the patient again began to improve. In May, I find a note that the wound was cicatrizing, and the discharge steadily lessening; in June, the patient sat up, and in July, began to walk with crutches; but it was now observed that his legs were becoming œdematous, and that his urine contained albumen. He went home, by his own request, shortly after this time, and I believe died some months subsequently, doubtless from amyloid disease of the liver and kidneys.

In the following case, both the age and constitutional condition of the patient, and the long duration of the disease, rendered the prognosis more than ordinarily grave, and yet the operation succeeded in giving the patient an excellent limb, and several years of useful activity:—

Excision of the Hip-Joint for Hip-Disease of eight years' duration; Recovery with useful Limb.—D., twenty-one years of age, applied to me at the University Hospital, in December, 1878, suffering from hip-disease of the right side, of eight years' standing. He walked with difficulty, with crutches, and was weakened by the continual discharge

from open sinuses, while a large cicatrix over the sacrum marked the site of a former bed-sore. He was unable to work, and was consequently dependent for his support upon a sister who could ill afford to maintain him out of her wages as a maid-servant. Under these circumstances, I did not hesitate to recommend an operation, and accordingly performed excision in the usual way, before my clinical class, on December 21, 1878. The operation presented no unusual features, and except that there was profuse suppuration afterwards, and a good deal of trouble from bed-sores, the patient's convalescence was uninterrupted by any special complication. The cure was completed in about six months, when the photographs were taken from which the annexed illustrations (Figs. 678, 679) are copied. They show on the one hand the amount of shorten-

Fig. 678.



Fig. 679.



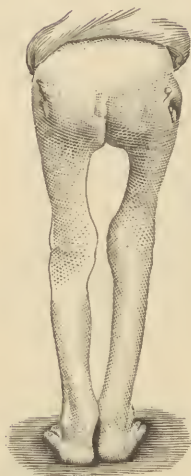
Result of hip-joint excision.

ing which followed the operation, and on the other the free range of motion which the patient had acquired. After his recovery he was employed in the hospital as a door-keeper and messenger, and the speed and agility with which he ran along the corridors, and up and down the long staircases, were a constant source of surprise to those who knew his history. After a time, I regret to say, he fell into bad habits, and Bright's disease was developed and ultimately proved fatal.

Once have I had occasion to excise *both hip-joints* in the same patient—the first instance, I believe, in which the double operation has been resorted to, though similar cases have been since recorded by Mr. Croft and Dr. Byrd. The result, in my case, was satisfactory as regarded the life of the patient, but he was not able to walk without crutches as long as he remained under my observation.

Excision of both Hip-Joints for Double Hip-Disease; Recovery.—C. G., a boy between eleven and twelve years of age, was admitted to the Children's Hospital in the autumn of 1872, suffering from hip-disease of *both sides*. In the *right* hip, the malady was of eight months' duration and in its second stage, but in the *left* hip was advanced to the third stage, with an abscess discharging behind the great trochanter. The boy's general health was much impaired by long-continued pain and suppuration. On September 9, 1872, I excised the left hip in the usual way, and removed a sequestrum from the acetabulum. The patient recovered rapidly from the operation, and by January, 1873, the wound was entirely healed. The disease on the right side, however, had meanwhile been progressing, and in April an abscess had formed and had undergone spontaneous opening, so that on the 23d of that month—seven and a half months after the preceding operation—I performed excision on the right side also. The head of the femur on this side was carious, but the acetabulum was healthy. A slight

Fig. 680.



Result of excision of both hip-joints.

reactionary hemorrhage occurred some hours after the operation, but was readily controlled by the application of cold and pressure; the greater part of the wound united by adhesion, but on May 4 and May 5 (the eleventh and twelfth days) there were free secondary hemorrhages, which left the patient quite blanched and exhausted. The bleeding did not recur, however, after this date, and convalescence though slow was henceforth uninterrupted. In August, 1873, the patient was sitting up, and able to work his way along the floor by leaning upon the back of a chair. In October, he could walk pretty well with crutches. He went home in April, 1874, and in October of that year I heard from him as still improving, though still requiring artificial aid in locomotion. The photograph from which Fig. 680 is copied was obtained before he left the hospital.

I have, in all, excised the hip-joint 21 times, in 20 patients, with 13 recoveries, 2 cases still under treatment, and 6 deaths, only one of which, however, appeared to have been hastened by the operation. Indeed, in two of the fatal cases, the patients may, as already mentioned, be fairly considered to have recovered from the operation, though dying from visceral disease many months afterwards. The particulars of these 21 cases are compendiously exhibited in the annexed table:—

TABLE SHOWING THE PARTICULARS OF TWENTY-ONE CASES OF EXCISION OF THE HIP-JOINT FOR HIP-DISEASE.

No.	Sex and age.	Duration of disease before operation.	Result; duration of treatment after operation.	Remarks.
1	Male, 5	One year	Recovered; $3\frac{1}{2}$ years	Perfect use of limb.
2	Male, 9	Two years	Died; nearly 1 year	Death from phthisis.
3	Male, 11	Eight months	Recovered; 19 months	{ These two operations on same patient; case of double excision.
4	Male, 12	Fifteen months	Recovered; 1 year	
5	Male, 5	Two years	Recovered; 7 months	Removed from hospital before utility of limb determined.
6	Male, 4	One year	Died; $3\frac{1}{2}$ months	Death from tuberculous meningitis.
7	Male, 14	Twenty months	Recovered; 1 year	Perfect use of limb.
8	Male, 20	Five years	Died; 6 months	Death from visceral disease.
9	Female, 7	Eighteen months	Recovered; 3 years	Useful limb.
10	Female, 8	Two years	Recovered; $3\frac{1}{2}$ years	Useful limb.
11	Female, 10	Three years	Recovered; $6\frac{1}{2}$ months	Useful limb.
12	Female, 8	Three years	Recovered; 5 months	Useful limb.
13	Male, 14	Several years	Recovered; 2 years	Useful limb.
14	Male, 6	One year	Recovered; $1\frac{1}{2}$ years	Useful limb.
15	Male, 21	Eight years	Recovered; 6 months	Useful limb.
16	Female, 10	Four years	Died; 2 weeks	Death from diarrhœa and exhaustion.
17	Male, 9	Five years	Recovered; 2 months	Still used crutches when discharged.
18	Male, 17	Several years	Died; $4\frac{1}{2}$ months	Death from phthisis.
19	Male, 17	Many years	Died; 3 months	Death from phthisis and exhaustion.
20	Male, 6	Two years	Still under treatment	Doing well.
21	Female, 8	Two years	Still under treatment	Complicated by pelvic abscess.

The statistics of hip-joint excision have been particularly studied by several authors, myself included, but the largest number of cases yet tabulated is

embraced in Dr. Culbertson's well-known prize-essay, already so often referred to. The effect of *age* in influencing the result of the operation is as clearly marked as in the case of other articulations, the most favorable period of life for this excision being that between the ages of five and ten years, and the mortality in adult life being so large as only to justify the operation in exceptional instances. To illustrate this point, I have compiled the following table from Dr. Culbertson's figures of excisions for disease:—

TABLE SHOWING RESULTS OF EXCISION OF THE HIP-JOINT FOR HIP-DISEASE AT DIFFERENT AGES.

Age.	Total.	Recovered.	Died.	Result undetermined.	Mortality per cent. of terminated cases.
Under 5 years	51	29	18	4	38.3
Between 5 and 10 years	162	102	48	12	32.0
" 10 " 15 " 	85	40	35	10	46.7
" 15 " 20 " 	52	22	26	4	54.2
" 20 " 30 " 	39	11	22	6	66.7
Over 30 years	26	9	14	3	60.9
Age not stated	55	21	29	5	58.0
Aggregates	470	234	192	44	45.1

The effect of the patient's *constitutional condition* upon the result of the operation is, perhaps, less obvious than in the case of the other joints, for the reason that the subjects of hip-excision are, with few exceptions, all in impaired health. It may be said, however, that advanced visceral disease and exhaustion from long-continued and profuse suppuration, greatly diminish the chances of recovery, and that the most promising cases are those in which, in spite of the local disease, the patients have maintained a fair state of general health. At the same time, statistics lend no support to the views of those who advocate early excision in the treatment of hip-disease, Dr. Culbertson's figures showing very clearly that the operation is most successful in cases of from 9 to 18 months' duration:—

TABLE SHOWING RESULTS OF EXCISION OF THE HIP-JOINT IN CASES OF HIP-DISEASE OF DIFFERENT DURATION.

Duration of disease.	Total.	Recovered.	Died.	Result undetermined.	Mortality per cent. of terminated cases.
Under 3 months	5	...	3	2	100.0
Between 3 and 6 months	20	9	10	1	52.6
" 6 " 9 " 	10	5	5	...	50.0
" 9 " 12 " 	30	19	9	2	32.1
" 12 " 15 " 	10	10	...	...	0.0
" 15 " 18 " 	15	10	5	...	33.3
Over 18 months	165	99	57	9	36.5
Duration not stated	215	82	103	30	54.9
Aggregates	470	234	192	44	45.1

As in the case of the other joints, hip-excision is more successful when employed for *disease* than when for *injury*. The operation is almost never required for the relief of accidents met with in civil life, but the two cases of this kind referred to by Dr. Culbertson both terminated fatally, while in military practice, the mortality of the procedure, as shown by the table on

page 558, has been no less than 86.5 per cent. Comparing this with the death-rate of excision for disease (45.1 per cent.), we see that whereas in cases of the latter category more than half recover, in those of the former nearly nine-tenths die.

Partial excision—that is, removal of the upper end of the femur only—is somewhat more successful than *complete excision*, but the difference is so slight that the surgeon should not hesitate to take away all that is diseased. Dr. Culbertson's figures show that simple decapitation of the femur is less successful than excision embracing the neck and trochanters, as well as the head of the bone.

TABLE SHOWING COMPARATIVE RESULTS OF COMPLETE AND PARTIAL EXCISION OF THE HIP FOR HIP-DISEASE.¹

Form of Excision.	Total.	Recovered.	Died.	Result undetermined.	Mortality per cent. of terminated cases.
Complete excision	177	90	77	10	46.1
Partial excision	241	124	97	20	43.9
Form not stated	52	20	18	14	47.4
Aggregates	470	234	192	44	45.1

The *ultimate result* of hip-joint excision, as regards the utility of the limb, is in most cases quite satisfactory; in three of the four cases in Prof. Gurtl's tables, the end-result was "good," and in the remaining one "very good;" while of the 234 cases of recovery tabulated by Dr. Culbertson, there were 72 in which the result was "perfect" (30.8 per cent.), 106 in which the patients obtained "useful" limbs (45.3 per cent.), and only 13 absolute failures (5.6 per cent.), the utility of the preserved limb not having been noted in the remaining 43 (18.4 per cent.). Among my own cases—excluding that of double excision—11 instances of recovery have given 2 "perfect" and 7 "useful" limbs, while in the other two cases the patients passed from observation before this point could be determined.

Taking, however, all cases of excision for hip-disease together, the results of the operation cannot be said to be very brilliant, one out of three dying under the most favorable circumstances as to age, etc., and but a little over three-fourths of those who recover from the operation having been known to have useful limbs. Should then the operation be abandoned? I answer, certainly not. The question should be, not, what does excision promise, but rather, does any other mode of treatment promise as much? What, in fact, can those surgeons who oppose hip-joint excision offer in its place? The operation is, indeed, such a grave one, under any circumstances, that I do not consider a resort to it justifiable in any case in which it is not evident that life will be imperilled by longer persistence in expectant measures. A considerable number of cases of hip-disease run a mild course from beginning to end, and, with, or even without, treatment, terminate in spontaneous recovery, with more or less stiffness and deformity, it is true, but nevertheless, with fairly useful limbs; and even if an abscess forms, it by no means follows that a cure is to be despaired of. But in the majority of cases in which suppuration has occurred, there comes, sooner or later, a time when the only alternatives are excision, amputation, or a prolonged and fatal illness terminated by death. These patients very seldom—at least in the class of

¹ Culbertson, op. cit.

cases seen in hospital practice—recover under expectant treatment; they are carried from one hospital to another, and at last die worn out by suppuration or visceral disease, or are carried off from a life of pain and weariness by some intercurrent affection. Thus, twelve cases, observed by Gibert at the Hospital “Sainte-Eugénie,” furnished eight deaths, three “not cured,” and only one recovery. No one, probably, at the present day, would think it proper to *amputate* in any case of hip-disease in which excision was at all applicable; and, indeed, not to speak of the mutilation necessarily caused by hip-joint amputation, the mortality after this operation is not inconsiderable, at least nine out of thirty-four recorded cases of primary amputation for hip-disease having proved fatal; so that *excision* is, in a good many instances, the only available resource, and, as such, the surgeon should employ it without hesitation. In this respect excision of the hip-joint may be said to differ from that of any other articulation, and, as justly remarked by Mr. Holmes, “in cases which show a decided tendency to get worse, we may pretty confidently reckon all the recoveries after the operation as a clear gain.”

As may be seen by the table of cases under my own care, the after-treatment of hip-joint excision is sometimes greatly protracted. As long as the patient does well, and, if not gaining, is at least not losing ground, the surgeon must not despair, but should persevere with careful dressing and judicious constitutional and hygienic treatment, by the aid of which an ultimate cure may be hoped for. If, however, the discharge increase, and it be evident that caries has recurred, and is too extensive for spontaneous recovery, a *re-excision* may sometimes be practised with advantage; or, if, with the same local condition, the patient's general health begin to fail, *consecutive amputation* may be still looked to as a last resource, and may be practised with a reasonable hope of benefit, thirty-one recorded cases of this kind having given at least seventeen favorable results.

The following tables embrace thirty-four cases of *primary* and thirty-one of *consecutive* amputation at the hip-joint for hip-disease:—

CASES OF PRIMARY AMPUTATION AT THE HIP-JOINT FOR HIP-DISEASE.

No.	Operator.	Result.	No.	Operator.	Result.
1	Alexander	Recovered	18	Lee	Recovered
2	Allen	“	19	Mack	“
3	Baffos	Died	20	Macnamara	“
4	Böckel	Recovered	21	Maisonneuve	“
5	Cowell	“	22	Marshall	“
6	Cumming	“	23	Mason	“
7	Curling	Died	24	Richardson	“
8	Id. . . .	Recovered	25	Rivington	“
9	Davy	“	26	Id. . . .	Died
10	Duffee	“	27	Secourgeon	“
11	Foulis	“	28	Spofforth	Recovered
12	Hughes	Undetermined	29	Stokes	“
13	Hutchinson	Recovered	30	Stout	“
14	Id. . . .	“	31	Tay	“
15	Id. . . .	Died	32	Thompson	Died
16	Id. . . .	“	33	Wheatcroft	“
17	Kerr	“	34	Young	Recovered

CASES OF AMPUTATION SUBSEQUENT TO EXCISION OF THE HIP-JOINT FOR HIP-DISEASE.

No.	Operator.	Result.	No.	Operator.	Result.
1	Alexander . . .	Recovered	17	Holmes . . .	Died
2	Id.	"	18	Hulke	Undetermined
3	Armstrong . . .	Died	19	Jackson . . .	Recovered
4	Barwell	Recovered	20	Lucas	Undetermined
5	Id.	Died	21	Lyon	Recovered
6	Bellamy	Recovered	22	Marshall . . .	Died
7	Bruns	Died	23	Id.	Recovered
8	Davy	Recovered	24	Id.	"
9	Dawson	Undetermined	25	Murbach . . .	"
10	Elkington . . .	Recovered	26	Parker	"
11	Garden	"	27	Smyth	"
12	Gay	"	28	Spence	"
13	Gould	Died	29	Swain	Undetermined
14	Heyfelder . . .	"	30	Teale	Recovered
15	Holmes	"	31	Whitehead . .	Died
16	Id.	"			

Froeh has collected statistics of hip-joint excisions done with antiseptic precautions, and finds that one hundred and sixty-six cases gave seventy-six recoveries and forty-four deaths, the result in the remaining forty-six not having been ascertained. The mortality of terminated cases, according to these figures, was, therefore, 36.6 per cent., or 5 per cent. more than that in my own list of cases, in which no attempt was made to adopt Listerian measures. The fact is that the mortality after this operation is almost exclusively due to constitutional conditions, and very little dependent upon the management of the wound.

RESECTION OF THE FEMUR.—Excision in the continuity of the femur is an operation seldom called for or justified. In cases of compound fracture, the choice should rather be between pure expectancy (with removal of loose fragments, etc.) and amputation, and in cases of necrosis, when anything more than extraction of sequestra is necessary, ablation of the limb should be resorted to. Resection may be practised for the relief of ununited fracture, but in this part of the body is both a doubtful and a dangerous remedy, and, should milder measures fail to secure union, the patient will, as a rule, do well to be satisfied with the adoption of some mechanical means of support, such as that devised by Professor H. H. Smith, of Philadelphia,¹ rather than undergo the risks of a resection. Excision of a wedge-shaped portion of bone, as originally practised by Barton for bony ankylosis of the knee, has been probably more successful than any other form of resection in this situation, but is a less desirable operation than simple osteotomy, as recommended by Mr. Barwell,² and I must say the same of the operations for removing a disk of bone practised by Rodgers, Sayre, and Volkmann, in cases of bony ankylosis of the hip.³ Resection of one femur, to compensate for shortening in the other, was proposed and practised by Meyer, of Wurzburg, and his example has been occasionally imitated by other operators—a reckless form of surgery which seems to me quite without justification.

If the operation of femoral resection is to be done at all, it may be accomplished by making a longitudinal incision on the outer side of the limb, exposing the bone, and then removing as much of the latter as may be thought desirable, with a chain-saw.

¹ See Vol. IV. p. 59.

² See p. 529.

³ See pp. 526, 527.

The *statistics* of the operation present rather a melancholy picture. Of 175 cases tabulated by Drs. Otis and Huntington,¹ in which resection in the shaft of the femur for *gunshot injury* was performed during the American war, no less than 116 terminated fatally, a percentage of terminated cases of 69.4; the operation in Military Surgery is therefore much less successful than amputation of the thigh, the death-rate of which operation is given by the same authorities as 54.2 per cent.² Of 17 cases collected by Heyfelder,³ in which the operation was performed for *ununited fracture*, there were 10 successful and 1 "half successful," while 1 required subsequent amputation, and 5 ended in death (29.4 per cent.); and even the cuneiform operation of Barton (for ankylosis of the knee) has given 2 deaths out of 17 cases, a mortality of 11.8 per cent.⁴

Excision of the trochanter major may be required in cases of gunshot fracture, caries, or necrosis, and has been successfully performed by Tenon, Velpeau, Textor, Teale, Fergusson, Parker, of New York, and other surgeons. The bone may be exposed by a straight or curved incision, and the diseased parts removed with the gouge and forceps.

EXCISION OF THE KNEE-JOINT.—This operation is chiefly employed in cases of chronic disease of the articulation, though it has also been practised for compound fracture or dislocation, and for ankylosis, whether fibrous or bony; in the latter case by the method introduced by the late Dr. Gurdon Buck, of New York, and since described as "excision in a block." As already mentioned, knee-joint excision was first performed (successfully) by Filkin, of Norwich, in 1762, and again successfully by Park, in 1781. So little favor, however, did the operation receive at the hands of surgeons generally, that forty years ago it had been performed in all less than twenty-five times. Revived by Textor, in Germany, and by Sir W. Fergusson, in England—the last-named surgeon having operated for the first time in 1850—the operation has since been so largely employed that its statistics, in civil practice, are now considerably more extensive than those of any other excision. The first excision of the knee-joint in this country was performed by Dr. Kinloch, of Charleston, in 1856. The first knee-excision in Military Surgery was that of Fahlé, in 1851.

Various incisions have been adopted for this operation, those which have met with most approval being the **H**-shaped, the semilunar or **U**-shaped, and the simple transverse incision. Treves, of Margate, has revived a suggestion of Jeffray and Sédillot, and advises that lateral incisions only should be employed, without any transverse wound.

The **H**-shaped incision was first employed by Moreau, has been adopted by Butcher, of Dublin, and is still preferred by some surgeons, including Prof. Hamilton, of New York. It consists of two longitudinal incisions, one on either side of the joint, with a transverse cut immediately below the patella. Provided that care be taken to place the lateral incisions far back, so as to allow of free drainage, this method answers a good purpose, and is certainly easier for the beginner than either of the other forms of operation; it, however, makes an unnecessarily large wound, and is, in my judgment, far inferior to the operation by transverse incision.

The **U**-shaped, horse-shoe, or semilunar incision (Fig. 681), was introduced by Mackenzie, and is now advocated by such high authorities as Prof. Hum-

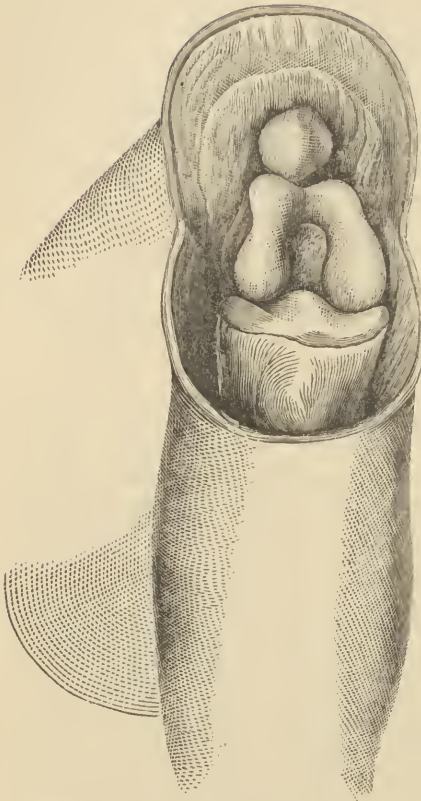
¹ Medical and Surgical History, etc., Third Surgical Volume, p. 875.

² *Ibid.*, p. 877.

³ *Op. cit.*, p. 82.

⁴ Culbertson gives 14 cases (*op. cit.*, pp. 268-275), to which may be added three successful operations, respectively recorded by the late Dr. Blackman, of Ohio, Mr. J. E. Adams, of London, and Mr. Kilgariff, of Dublin.

Fig. 681.



Excision of knee-joint by semilunar incision.

phry, of Cambridge, Prof. Erichsen, of London, and Prof. Gross and Prof. Agnew, of Philadelphia. This method consists in raising an anterior flap containing the patella, the base of the flap reaching to above the femoral condyles. The ligamentum patellæ is divided in the first incision, when, the crucial and lateral ligaments being cut, the articulating extremity of the femur can be readily excised with a Butcher's saw. The limb being then flexed and forcibly thrust upward, the extremity of the tibia can be made to protrude, and may be removed with the same instrument. This method makes a smaller wound than the H-shaped incision, but does not afford such free access to the joint.

By far the best procedure, in my judgment, is that originally suggested by Park, in the postscript to his famous letter to Mr. Percival Pott, but which seems to have been first employed by Textor, Kempe, of Exeter, and Sir William Fergusson. It consists in making a single, transverse incision across the front of the joint, immediately below the patella, the extremities of the wound being carried well backwards, so as to ensure free drainage during the after-treatment. (Fig. 682.) When the limb is much contracted, as it often is in these cases, this incision, though made transverse to the axis of the tibia, forms, when the limb is extended, a somewhat

obliquely curved wound with its convexity downwards, and thus really constitutes a flap operation. By dividing the ligamentum patellæ, the joint is opened, and the surgeon then proceeds to divide the lateral ligaments, and the crucial ligaments if any portion of these is remaining.

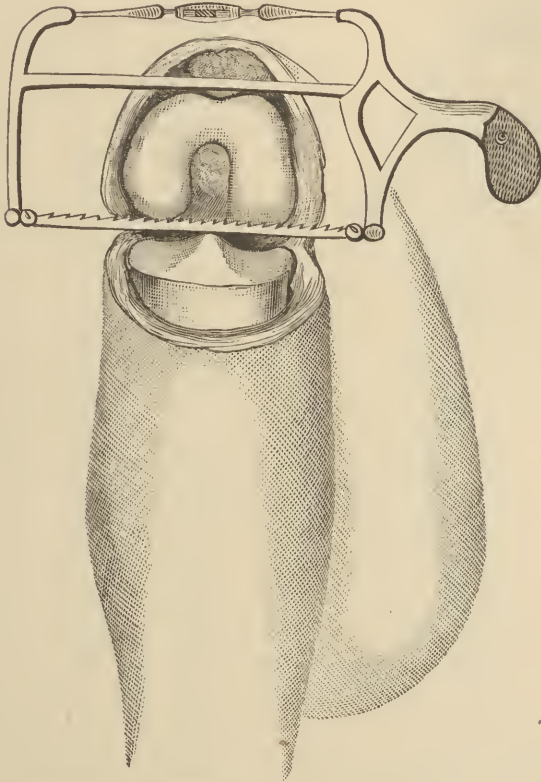
The next step is to clear the condyles of the femur for the application of the saw, and it is here ordinarily recommended to dissect back all the overlying tissues, including the patella, which is subsequently removed from within; but this, in cases in which the parts are much thickened and infiltrated, is a very troublesome business, and when it is accomplished the result is not very satisfactory, for the cavity left by removing the patella almost invariably suppurates, and, as a consequence, abscesses form, and leave persistent sinuses above the wound. Moreover, all that is really needed as a covering to the bone is the skin and subcutaneous fascia, and hence in all my more recent cases I have simply dissected these back to the level at which I meant to apply the saw, and have then cut directly down to the bone, thus removing together the extremity of the femur and the patella, with the diseased tissues by which the latter is surrounded.

For clearing the posterior surface of the condyles, I employ the strong probe-pointed knife with limited cutting edge, recommended by Mr. Erich-

sen (Fig. 634), having, I confess, a strong objection to the use of sharp-pointed instruments in the neighborhood of the popliteal vessels.

For making the bone-sections, I invariably employ Butcher's saw, reversing the blade so as to divide the bone from below upwards.

Fig. 682.



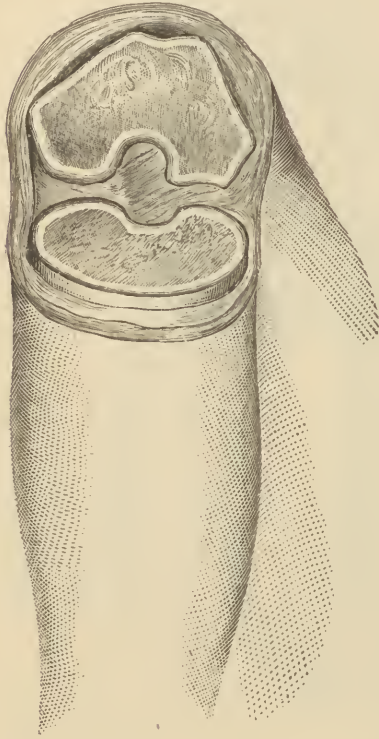
Excision of the knee-joint by single transverse incision.

In removing the articular extremity of the femur, it must be remembered that the internal condyle is situated lower than the external, and that hence the line of section must be parallel to that of the free surface of the condyles, and, therefore, oblique to the axis of the femoral shaft, as otherwise the natural inclination of the limb would not be preserved. As, too, the epiphyseal line is higher in front than behind, a safe rule is, that the condyles should be sawn in a plane, *which, as regards the axis of the femur is oblique from behind forwards, from below upwards, and from within outwards.* The tibia should be sawn in a plane transverse to the long axis of the bone, with a slight antero-posterior obliquity to correspond with that of the section of the femoral condyles. In order to avoid interfering with the epiphyseal junction, and thus hindering the future growth of the limb, care must be taken not to remove the whole of the condyles; it is quite sufficient to take away the anterior portion—that which articulates with the tibia in the position of extension—a slice varying from half an inch to an inch in thickness, according to the size of the bone. From the tibia a still smaller portion may be removed, all that is needed here being to obtain a smooth section to be opposed to that of the femur. It is a good plan to snip off the sharp

posterior edges of both bones with cutting pliers, so as to avoid all risk of injury to the tissues of the popliteal space.

The bone-sections having been made (Fig. 683), the surgeon should examine the condition of the sawn surfaces, and deal with any softened or carious

Fig. 683.



Excision of the knee-joint; the operation completed.

patches by the free use of the gouge and osteotrite. The same plan may be pursued with any portion of diseased bone or cartilage beyond the line of section.

The next step of the operation is to clip away, with scissors curved on the flat, or with Mr. Butcher's "knife-bladed forceps," any shreds of disorganized synovial membrane or ligament, taking care, however, not to disturb the floor of the wound, which should, if possible, be left intact.

The surgeon may next proceed to adjust the resected bones, when, if they cannot be brought into position by any justifiable amount of force, he should divide the hamstring tendons, and if this does not suffice, must remove an additional slice of bone.

All bleeding vessels having been carefully secured by ligature, the wound may be brought together by stitches, and the limb adjusted upon the splint which is to be employed during the after-treatment. This adjustment is, I think, best effected while the limb is elevated to nearly a vertical position, there being under these circumstances no difficulty in

keeping the bones together, while, if brought down to a horizontal line, there is a constant tendency to displacement from the weight of the leg. The application of the splint should be completed before the patient is allowed to recover from the state of anæsthesia, which should be fully maintained during the whole operation.

Two points still require notice in regard to the operation itself: first, as to the control of bleeding during the operation, and second, as to the mode of dealing with the patella.

I employ no tourniquet nor other means of interrupting the circulation during the operation; no large vessel is divided, and I believe it much safer to tie each small artery as it is cut, than to run the risk (which is by no means only theoretical) of having consecutive hemorrhage from vessels which, under temporary compression, have retracted, and which do not bleed until the patient becomes warm in bed.

Even if the patella is not itself diseased, it should, I think, be removed; as the after-treatment aims at obtaining bony union, the patella is of no use, and statistics show that the risks of the operation are greatly increased by its retention. Pénrières finds that while the removal of the patella diminishes

the risk of death by nearly one-third, its retention more than doubles the probability of subsequent amputation becoming necessary.

Two variations in the mode of performing this operation deserve a brief notice. Mr. Golding Bird has recently suggested,¹ under the name of "trans-patellar excision," that the patella should not be removed, but should be sawn across, its segments being turned upwards and downwards so as to expose the joint, and being finally re-approximated with carbolized silk sutures. I confess that this modification of the ordinary operation does not impress me as being an improvement. I see nothing to be gained by retaining the patella, while, on the other hand, if its retention were thought desirable, it could certainly be accomplished better by Jeffray's and Treves's plan, already referred to, in which only lateral incisions are made. The other variation is one of much greater plausibility, introduced by Prof. G. E. Fenwick, of Montreal, and consists in sawing both femur and tibia in a curved line, so as to make them fit together more closely and accurately than they would do otherwise. This mode of procedure has proved very successful in the hands of Dr. Fenwick himself, who has kindly furnished me with an account of his operation, which will be found at the end of this article.

One of the chief difficulties to be contended with during the after-treatment of knee-joint excision, is to prevent the anterior projection of the cut extremity of the femur; to obviate this, the surgeon may, particularly in cases of children, fix the bones in apposition by means of a strong metallic suture, as originally employed under these circumstances by the late Dr. Gurdon Buck, of New York. In operations upon adults, however, this will not, I think, usually be found necessary, particularly if the bone-sections be made, as above recommended, in a plane slightly oblique from behind forwards and from below upwards—a suggestion which appears to have originated with Billroth, and which is readily carried out with the aid of Butcher's saw.

The points specially to be considered with regard to the after-treatment, are the choice of a splint, the position in which the limb is to be kept, and the frequency with which it should be dressed.

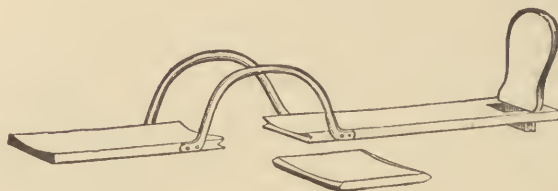
An excellent splint for the after-treatment of knee-joint excisions, is that known as Price's, which consists of a posterior metal splint, cut away beneath the knee, with an arrangement by which it can be lengthened or shortened, a bracketed wooden external splint to guard against outward bowing (to which there is always a strong tendency in these cases), and a movable wooden foot-piece. The objections to Price's apparatus are its expense, and its complicated nature. Butcher's "box-splint" has answered a very good purpose in the hands of its introducer, but seems to me unnecessarily cumbersome, and the same may be said of the tin splint which is, I believe, generally used in Boston. Dr. Watson, of Edinburgh, employs a posterior moulded splint, with an anterior bracketed rod by which the limb can be suspended, and this splint, with slight modifications, is that preferred by Dr. Fenwick.

The splint which I used in my earlier operations was a bracketed wooden splint (Fig. 684), with a movable foot-piece, simplified, and as I thought improved, from that originally introduced into the Episcopal Hospital of Philadelphia, by my colleague, Dr. Packard, the latest development of whose apparatus is shown in Fig. 685. The great merits of this wooden splint were its simplicity and cheapness: it was, however, necessarily heavy, and, the wood getting saturated with the discharge, it became after a time offensive; hence of late years I have preferred the bracketed wire splint shown

¹ *Lancet*, Jan. 20, 1883.

in Fig. 686, the splint being of course well padded, and the thigh, leg, and foot firmly fixed with broad strips of adhesive plaster and bandages. The

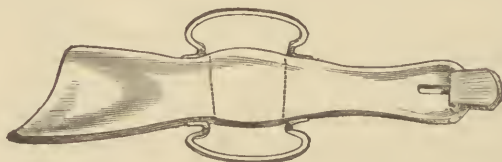
Fig. 684.



Bracketed wooden splint for after-treatment of excision of the knee.

essential points to be provided for are *absolute immobility of the limb* and *ready access to the wound*, and both of these requisites are perfectly secured by using

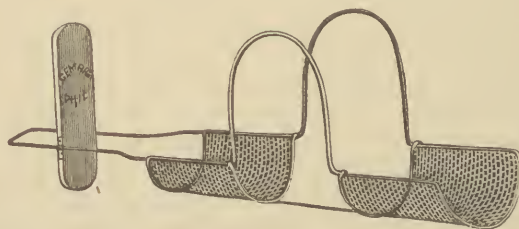
Fig. 685.



Packard's splint for after-treatment of excision of the knee.

the splint here described. When the splint has been adjusted, the limb should be laid on a pillow, or, better still, in a large and loose fracture box.

Fig. 686.



Bracketed wire splint for after-treatment of excision of the knee.

Any tendency to anterior projection of the femur may be counteracted, as advised by Mr. Butcher, by using in addition a short *anterior* splint, while the risk of outward bowing may be prevented by using an *external* splint, a metal spring and truss-pad, as ingeniously suggested by Mr. Swain, or, which I have found amply sufficient, a strip or two of adhesive plaster, looped around the outside of the limb and secured to the inner side of the splint.

In what position shall the limb be placed after excision of the knee? Some surgeons recommend a slightly flexed position, believing that a somewhat bent limb is more useful than a straight one. This I regard as an error; a stiff *unresected* knee is no doubt better when ankylosed at a slight angle, so as to enable the patient to walk without swinging out his limb like that of a compass; but by excision the limb is necessarily so much shortened as to obviate any risk of this compass-like motion, and, consequently, the straighter

it can be made the better it will be for the patient. I have had the opportunity of comparing the results of both methods in practice, and have no hesitation in deciding in favor of the straight position.

No rule is more important in the treatment of these cases than that the limb should be undisturbed after the operation. The wound, of course, must be dressed daily, but when the splint is once applied there should be no necessity for readjustment until the process of bony union is well advanced; six weeks is none too long for the splint to remain without renewal, and under no circumstances should it be disturbed within the first fortnight. I believe with Price and Swain that a neglect of this rule has been answerable for many of the failures of knee-joint excision. In the later stages of the after-treatment I have found it convenient to replace the bracketed splint by a simple, moulded, pasteboard gutter, made to embrace the posterior half of the limb.

Should, unfortunately, caries or necrosis recur after excision, a *re-excision* may be properly attempted, or, if the patient's health be failing, *amputation* may be resorted to as a life-saving measure. Re-excision may also be required for *recurrent deformity with ankylosis*, and I have successfully employed it under these circumstances. In two cases have I known flexion of the limb to occur after recovery from knee-joint excision, when the bones were, to all appearances, firmly united. In the first case, I succeeded in straightening the limb without any difficulty by applying a posterior, straight splint, and an elastic bandage, which soon brought the knee down into position; but in the other case the patient was lost sight of for seven years, at the end of which time complete synostosis had occurred with the leg at a right angle to the thigh, and I then successfully re-excised after Buck's method (excision in a block), and the patient has now a straight and useful limb, though of course shortened by the double operation.

As in the case of other articulations, I shall endeavor to further illustrate the subject of knee-joint excision by giving abstracts of a few cases¹ from among those in which I have had occasion to perform the operation.

Partial Ankylosis with Recurrent Arthritis of Right Knee; Excision; Recovery with Useful Limb.—The portions of bone removed in this case were exhibited in their recent state to the Pathological Society of Philadelphia, at its meeting of March 24, 1870, and a brief note of the case appeared in the proceedings of that body.² The patient was a boy, ten years of age, who four years previously had received an injury of the right knee, and had been subsequently treated in various hospitals with but temporary benefit. When admitted to the Episcopal Hospital, where he came under my observation, in March, 1870, the joint was found to be markedly distorted, the limb being contracted to an angle of about 120°, the tibia dislocated backwards and upwards, and the patella firmly fixed upon the external condyle of the femur. There was partial ankylosis; the joint was tender and at times painful; and the frequent falls to which the boy was exposed by the inability to use his limb, led to oft-recurring attacks of inflammation, each of which left the part more crippled than it had been before.

Under these circumstances it was determined to resort to excision, and accordingly, on March 23, the patient being under the anæsthetic influence of ether, I made a single curved incision over the front of the joint, dissected out the patella, and, having with a probe-pointed knife fairly exposed the ends of the femur and tibia, removed their articulating extremities with the saw known as Butcher's, its blade being fixed so as to cut from below upwards, and thus to avoid all risk of injury to the important structures in the popliteal space. The disorganized soft tissues of the joint having then been clipped away with Butcher's knife-bladed forceps, a few small vessels were secured with

¹ Several of these cases, as well as some of those of elbow-joint excision, were included in papers read before the College of Physicians of Philadelphia in 1875 and 1876. (Transactions, 3d series, vols. i. and ii.)

² Proc. Path. Soc. Phila., vol. iii. p. 164.

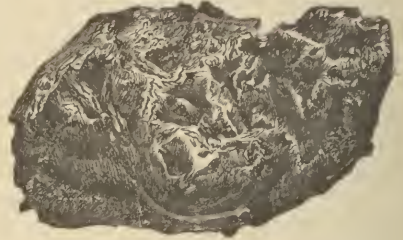
ligatures, the edges of the wound were brought together with numerous points of the interrupted wire suture, and, the resected bones having been carefully adjusted, the limb was firmly fixed upon a well-padded, posterior, bracketed splint, the wound lightly dressed, and the patient restored to bed.

But little need be said as to the subsequent progress of the case; the wound was dressed daily, but the limb was not taken from the splint until cleanliness required its removal, and then the parts were firmly held by an assistant until the padding of the

Fig. 687.



Fig. 688.



Articulating surfaces of femur and tibia removed by excision of the knee-joint.

splint had been renewed, when everything was readjusted as before. When the union of the resected portions was sufficiently advanced, the bracketed splint was exchanged for a simple, moulded, pasteboard gutter, and this in turn was ultimately replaced by a

Fig. 689.



Partial ankylosis and recurrent arthritis of knee. Before operation.

Fig. 690.



The same patient. Result of excision of knee-joint.

soap plaster and bandage. The greater part of the wound healed by adhesion, and on August 18, 1870 (nearly five months from the date of operation), the patient was quite well, his leg firmly united at a slight angle, and able to walk without crutch, cane, or other assistance, and with no pain. The shortening of the limb was noted as two and three-quarters inches, but part of this was the result of a fracture of the thigh which had been received some years before.

The appearances of the excised portions of bone, showing ulceration of the articular cartilages with erosion of the subjacent osseous tissue, may be seen in Figs. 687 and 688. The condition of the patient before and after operation is shown in Figs. 689 and 690.

The above case is a fair example of a large number met with in practice, particularly amid the class of patients by whom our hospitals are chiefly filled. A stiff knee-joint, by itself, can seldom be thought to require so serious an operation as excision, the deformity being usually remediable by milder measures. But when im-

perfect ankylosis, in a bad position, is complicated by the frequent recurrence of arthritis, the case (provided that there be no contra-indication in the age and general condition of the patient) is one in which little or no benefit can

be hoped for without operation, and in which excision may be resorted to with every prospect of a favorable result.

Arthritis of Knee of six years' standing; Limb deformed and useless; Excision; Recovery with Useful Limb.—The patient in this case was presented at a meeting of the College of Physicians of Philadelphia, held on February 21, 1872, and a note of the case appeared in the Transactions of that body.¹ The patient, Mary M., eleven years of age, was admitted to the Episcopal Hospital on February 24, 1871. At the age of five, she had suffered from smallpox, following which disease she had arthritis of both elbows and of the right knee. In the elbows, firm ankylosis ensued, and, the joints being flexed at convenient angles, she enjoyed very good use of her upper limbs. In the knee, however, the arthritis recurred from time to time (the last acute attack having been about two months before the date of the patient's entrance to the hospital), and the appearance of the joint, on her admission, was quite characteristic of advanced disease of the articulation. The knee was flexed to a right angle and much swollen, the subcutaneous veins enlarged, and the tibia dislocated backwards and outwards. The joint was tender on pressure, and painful when moved, and the patient thin and anæmic.

Excision was performed on February 28, 1871, a single transverse incision affording access to the joint; the parts removed were the condyles of the femur, the articulating surface of the tibia, and the patella. Five or six small vessels were secured with ligatures, the wound was closed with wire sutures and lightly dressed with oiled lint, and the limb was carefully adjusted upon the bracketed splint, which was not changed until some time in the fourth week.

Convalescence was retarded by a profuse epistaxis which occurred a few days after the operation, leaving the patient blanched and exhausted, by rather profuse suppuration (several abscesses having formed above the site of excision), and by a troublesome diarrhoea which, beginning in the month of April, continued at intervals through the summer, and at one time became a really serious complication. Firm, bony union was completed about the third or fourth month, but several superficial sinuses persisted, and did not entirely heal until several months subsequently. A year after the operation the patient walked readily, without any assistance whatever, though with a perceptible limp due to the shortening, which was found by measurement to be an inch and three-quarters. She had grown considerably, was fat and hearty, and in every way offered satisfactory evidence of the advantages to be derived from this particular branch of conservative surgery. This patient has been frequently seen since her discharge from hospital, and it has been ascertained that the benefits derived from the operation have been permanent.

The accompanying illustrations (Figs. 691 and 692), from photographs, show the appearance of the patient before operation and after recovery.

Fig. 691.

Arthritis of knee-joint.
Before operation.

Fig. 692.

The same patient after ex-
cision of the knee-joint.

¹ Trans. Coll. Phys. Philada., 2d S., vol. iv. page 413.

In the next case, the disease, though of shorter duration, had run a more acute course, the joint having suppurated, and being open at the time of the operation.

Excision of Right Knee for Chronic Arthritis with Intra-articular Abscess; Recovery with Useful Limb.—The subject of this case, Henry S—, was a young man, eighteen years of age, who entered the Episcopal Hospital on January 4, 1872. He had been suffering from disease of the right knee-joint for one year, during the last three months of which the articulation had been suppurating and discharging externally. The joint was greatly swollen, and the surrounding soft parts much infiltrated with the products of inflammation, but as the diseased action seemed to be limited to the articulation itself, and as the patient's general condition was satisfactory, it was thought proper to make an attempt to save the limb by excision.

Accordingly, on January 11, 1872, the patient being thoroughly etherized, the joint was laid open by a single, transverse incision below the patella, when this bone was removed together with the articulating extremities of the femur and tibia, the articular cartilages on both of the latter being found to have been almost entirely destroyed. But two ligatures were required, and, the wound having been closed with wire sutures and dressed with oiled lint, the limb was carefully adjusted on a posterior bracketed splint in the usual way. The greater portion of the wound united by adhesion, and, though convalescence was delayed by the formation of several superficial abscesses, the progress of the case was upon the whole satisfactory.

Fig. 693.



Result of knee-joint excision; slight motion preserved.

In January, 1873, one year after the operation, the patient walked with crutches, without any support to the resected limb, which was an inch and a half shorter than its fellow. There was still slight motion of flexion and extension at the knee, but no lateral movement whatever. There were two or three small sinuses, with superficial caries, but not connected with the site of excision. On January 21, the patient fell and sustained a fracture of the fibula of the resected limb, but did not injure the knee, thus furnishing a pretty good test of the sufficiency of the repair which had taken place. This accident was recovered from in a few weeks, and by March 25, the patient walked with a single crutch; on April 30, the sinuses were nearly healed, and he walked readily with a cane, and for short distances without even that support; and on May 4, he was made an out-patient. I heard from him afterwards at intervals, the last time about four years after the operation; his limb had long been healed, and he walked readily with a cane; he supported him-

self by peddling vegetables from a cart, and came several miles to town, twice a week, to go to the theatre.

The appearance of the resected limb is shown in the annexed illustration, from a drawing by Dr. Martinez. (Fig. 693.)

Though I have always endeavored to secure bony union after excision of the knee-joint (believing it to be safer to do so), yet I have in two cases succeeded in obtaining very useful limbs, while slight motion still remained in the direction of flexion and extension; indeed, provided that there be no lateral movement, such a result is by no means disadvantageous, the slight yielding of the limb antero-posteriorly enabling the patient, I think, to walk with a less apparent limp than if the part is entirely immovable.

Arthritis of Left Knee, the Result of Injury; Abscess communicating with Joint; Excision; Rapid Recovery with Useful Limb.—James H., a boy nine years of age, was admitted to the Episcopal Hospital on November 16, 1871, suffering from an "injury"—probably a contusion—of the knee, which was followed by arthritis, and by the formation of an abscess in the thigh, immediately above the joint, with which

it subsequently communicated. This abscess had been opened in December, and in January, 1872, when I took charge of the case, I found the parts in a quiet condition, but the ligaments of the joint very much relaxed, and its structure evidently disorganized. Excision was performed in the usual way on January 25, the semilunar cartilages being found much diseased, though the articular surfaces of the femur and tibia were but slightly eroded. Only one ligature was required, and the limb was placed on a bracketed splint and dressed in the usual manner. The patient convalesced rapidly; osseous union occurred quickly between the resected bones; and the patient was discharged, cured, with an excellent limb, on June 12, 1872, about four and a half months after the date of excision. The result of the operation may be seen by the accompanying illustration (Fig. 694), from a photograph taken shortly before the patient left the hospital.

Fig. 694.



Result of knee-joint excision.

In the next case, as in that of Henry S., a most useful limb was obtained, although without the occurrence of bony union.

Excision of Left Knee-Joint for Arthritis of two years' standing; Recovery with Useful Limb.—Annie McS., nine years of age, entered the Children's Hospital on October 8, 1873, suffering from arthritis of the left knee, with partial ankylosis, and consecutive outward and backward dislocation of the tibia. The condition of her limb rendered her very helpless, and by preventing her from going to school seriously interfered with her acquiring an education. As her disease, moreover, was of two years' standing, and was manifestly too far advanced to offer much prospect of recovery without operation, immediate excision was determined upon, and was performed in the usual way on October 14, 1873, only one

Fig. 695.

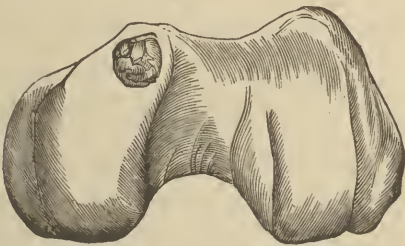


Fig. 696.



Parts removed in excision of the knee-joint.

ligature being required, and the wound being dressed and the limb supported in the ordinary manner. The articular cartilages were found much eroded, and a patch of caries existed on the outer condyle of the femur. The appearances of the resected parts are seen in the annexed illustrations. (Figs. 695 and 696.)

The operation was followed by very little constitutional disturbance; an abscess, which formed above the excision wound, was opened on October 18; the sutures were removed on the 20th, and the ligature came away on the day following. Union between the resected surfaces had begun by October 26, and by December 12, the cure was sufficiently far advanced to allow the bracketed splint to be replaced by a simple, moulded, pasteboard gutter, and the patient to sit up. By March, 1874, though slight motion still existed as regarded flexion and extension, the patient was able to walk without any aid, the limb being simply supported with a soap-plaster and bandage. One superficial sinus, which healed very slowly, caused the patient to be kept under observation an unusually long time, and she did not finally leave the hospital until the

Fig. 697.



Result of knee-joint excision; slight motion preserved.

summer of 1875 (nearly twenty months after the operation), previous to which she was presented at a meeting of the College of Physicians, and a photograph was secured, from which the annexed illustration (Fig. 697) is taken.

The case which follows is an example of that form of disease for which I have ventured to propose the name of *Gelatinous Arthritis*, and by its long duration, and long period of convalescence after operation, permits us to see one reason why so many surgeons have, in these joint affections, preferred the ready method of amputation to the more conservative but more tedious mode of treatment by excision.

Gelatinous Arthritis of three years' duration; Excision; Recovery with Useful Limb; Recontraction after several years; Re-excision; Second recovery with Useful Limb.—Rose U., eight years of age, was admitted to the Episcopal Hospital on March 25, 1874, suffering from gelatinous arthritis of the right knee, the disease having existed since her fifth year. She had been for a time a patient in the Orthopædic Hospital. Excision by the usual transverse incision was performed on March 30, no trace whatever being found of the semilunar cartilages, and the synovial structures being found in a "gelatiniform" condition, though the bones, in spite of the long duration of the disease, were but slightly affected. Three vessels were secured with ligatures, the wound was closed with lead wire sutures and dressed with oiled lint, and the limb was placed on the customary splint. By the system of rotation which prevails in the Episcopal Hospital, the patient passed out of my hands shortly after the operation, and I did not see her again, except casually, until I resumed the care of the wards in January, 1875. At that time the excision wound had cicatrized, and the resected

bones were firmly united, but a number of sinuses surrounded the limb, the soft parts were much thickened and infiltrated, and the scar presented a remarkable, prominent, keloid-like appearance.

On January 4, I removed the bracketed splint, upon which the limb had hitherto been kept, and substituted a moulded, pasteboard gutter, covering the site of the excised joint with compound iodine ointment, and a soap-plaster and firm bandage. Under this treatment the swelling rapidly subsided, and the keloid-like appearance of the cicatrix disappeared, and by the middle of the month the patient walked readily with crutches. In April both splint and crutches were dispensed with, and from that time Rose walked, and even ran, without any artificial assistance. She was kept in Hospital some months longer, as a few sinuses persisted, but was ultimately discharged with apparently firm bony union, and a perfectly straight leg. I now lost sight of this patient for over seven years, but in October, 1882, she applied to me at the University Hospital, with her knee contracted to a right angle, and immovable. The contraction she said had been coming on for about two years. Shortly after this date I operated again, by sawing out a wedge-shaped block from the angle of the limb, as in Dr. Gurdon Buck's method. The result of the re-excision was favorable, and Rose has now again (October, 1883), a straight and firm limb, and walks without artificial aid.

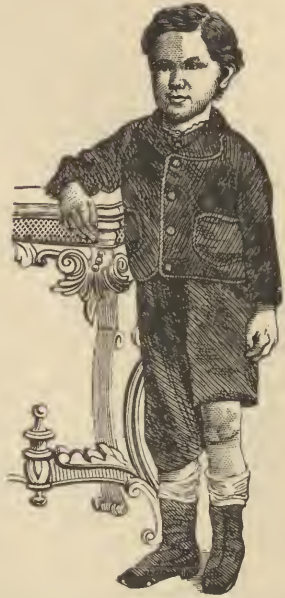
In my next case, which was also one of gelatinous arthritis, the operation was followed by profuse secondary hemorrhage on the thirteenth day; notwithstanding which the patient made an excellent and even rapid recovery.

Excision of Knee-Joint for Gelatinous Arthritis; Secondary Hemorrhage; Recovery with Useful Limb.—James M., six years of age, entered the Episcopal Hospital on May 7, 1875, suffering from gelatinous arthritis of the left knee, following an injury

which had been received one year before. The joint was much swollen, and the limb was useless, but there was not much pain, and, as customary in this variety of arthritis, not much impairment of motion.

Excision was performed in the ordinary way on May 13, six or seven ligatures being required, and the limb being subsequently dressed as in my other cases. On the eighth day, all the ligatures and sutures were away, the wound was mostly united, the limb was in excellent position, and everything promised an uninterrupted recovery. On the thirteenth day (May 26), without any obvious cause, profuse secondary hemorrhage occurred, the wound being stuffed with clots, and the dressings saturated with blood. Knowing that no large vessel had been divided in the operation, and unwilling to interfere unnecessarily with the progress of repair, I did not open the wound, but contented myself with applying an ice-bag and elevating the limb. The bleeding did not recur, the clots which had formed, gradually became disintegrated, and were spontaneously discharged, and the wound healed by granulation. In July the patient could walk with the support of a simple pasteboard splint, and in August even this was dispensed with, bony union of the resected bones being by this time completed. The patient was retained in hospital until October, 1875, a photograph, from which the annexed illustration (Fig. 698) is taken, having been obtained before his discharge. He was seen shortly afterwards in the neighborhood of the hospital, taking an active part in a stone fight with other boys.

Fig. 698.



In the next case, one of excision for gelatinous arthritis, in an adult, I was obliged to abandon the attempt to preserve the limb; amputation of the thigh was adopted as the only means of saving life, and was followed by rapid convalescence.

Excision of the Knee for Gelatinous Arthritis of three years' standing; Recurrence of Caries; Amputation; Recovery.—J. W., an Englishman, 28 years of age, and a machinist by occupation, was admitted to the Episcopal Hospital on January 27, 1876, suffering from disease of the left knee-joint of three years' duration, but which had incapacitated him from going about for only a few months. The case was recognized as one of gelatinous arthritis in an advanced stage, the joint being much swollen and misshaped, doughy, and fluctuating; it was painful and tender to the touch, with starting pains at night, and relaxation and manifest disorganization of the ligamentous structures. Extension was applied by means of a weight and pulley, and the limb placed at rest in a long fracture-box, while the joint itself was dressed with various topical remedies of a soothing and resolvent character, tonics, and a moderate amount of stimulus, being at the same time administered internally. During February, it became evident that intra-articular suppuration had occurred, and the joint was accordingly tapped with an exploring trocar, giving exit to a considerable quantity of partially purulent fluid.

Although some relief was afforded by the various measures above referred to, no permanent improvement occurred, and in the early part of March, as the patient's general health was failing, it became obvious that more radical interference was required. Excision was determined on, rather than amputation, because the morbid action in the joint was strictly confined within the limits of the articulation, and because there was at least no positive evidence of the existence of any visceral complication.

Accordingly, on March 9, 1876, the patient having been brought under the influence of ether, I excised the joint in the usual way, making a single transverse incision below the patella. The operation presented no peculiar features except that it was attended with unusually free bleeding, requiring the application of eight or nine ligatures. The ligamentous and synovial tissues were found, as had been anticipated, reduced to a gela-

tiniform condition, the semilunar cartilages having almost disappeared, the articular cartilage of the femur being widely eroded, and the femoral condyles deeply carious; a patch of caries, too, existed on the patella, but the tibia was healthy. The joint contained pus, and a large suppurating bursa extended upwards beneath the tendon of the quadriceps extensor femoris. The edges of the wound were approximated with iron-wire sutures, the line of incision was dressed with oiled lint, and the whole limb was firmly fixed in the bracketed wire splint, previously well padded with tow, and secured with broad strips of adhesive plaster and bandages. The patient was then restored to his bed, and the resected limb, splint and all, supported on a pillow, in a large, loose fracture-box.

A good deal of constitutional disturbance followed the operation, but, upon the whole, the patient's progress was for some weeks satisfactory. I find a note, on March 20, that all the sutures and ligatures were away, the wound united, the discharge lessening, and union of the resected bone-surfaces beginning. The pulse-rate, however, kept up to 120 or more, and the patient continued, as he had been since the operation, fretful and desponding. During April, it became evident that caries had recurred at the inner side of the limb, and in May it was noted that abscesses had formed above and below, that the discharge was increasing, and that the bones were less firmly united than they had been a fortnight before; with the approach of warm weather, too, the patient's strength began to fail, and we were forced to see that a further attempt to save the limb would seriously endanger the patient's life.

On May 19, therefore, a little more than ten weeks after the date of excision, I amputated at the junction of the middle and lower thirds of the thigh, cutting anterior and posterior flaps, the former from without inwards, and the latter by transfixion. From the time of this operation the patient convalesced without a single bad symptom; he was as cheerful and happy without his leg as he had been gloomy and discontented with it. The flaps united by adhesion; the last ligature dropped on the fourteenth day; on the fifteenth the patient sat up; and on the twenty-fifth the stump was sufficiently solid for him to begin to walk with crutches. On July 3, he was made an out-patient, and has been frequently seen since, in excellent health and spirits; several osseous spicula have come away from his stump, in which one sinus still persisted in January, 1877.

Could the operator invariably recognize in advance those cases in which the powers of nature were, and those in which they were not, likely to prove sufficient for the process of repair after excision, this department of surgery would approximate to the rank of an exact science, and such a history as that just recorded would never have to be written; but, as the matter stands at present, it is surely the surgeon's duty to give the patient the benefit of the doubt, and, if amputation is not manifestly called for, to attempt the conservative operation of excision; knowing that, if necessary, the limb can be subsequently removed with comparatively little risk to life—less, indeed, according to Pénrière's and Culbertson's statistics, than attends amputation of the thigh for disease in general.

Excision of Knee for Partial Anchylosis with Arthritis of nineteen years' duration; Recovery with Useful Limb.—The subject of this case, Kate H., twenty-six years of age, was sent to me by Dr. W. H. Bunn, of Philadelphia, and was admitted to the Episcopal Hospital on March 20, 1876. She had suffered more or less from disease of the left knee since she had been seven years old, the last attack having kept her in bed six months, and the joint at the time of her admission being very painful and tender, swollen, and somewhat contracted; the tibia was displaced backwards, and distinct grating was elicited on moving the articulation, while the characteristic "jumping" or "starting" pains at night showed the erosion of the articular cartilages, and the implication of the underlying bone. The patient's general condition was, however, satisfactory, and there was no evidence of the presence of any visceral disease.

After consultation with my colleagues, I excised the joint in the usual way on March 24, securing the limb after the operation in the bracketed wire splint, and placing the

whole on a pillow and in a large fracture-box. The condition of the joint, when it was laid open, amply justified our decision as to the necessity of interference, the semilunar cartilages having entirely, and the crucial ligaments almost, disappeared, the articular cartilages being eroded, and the femoral condyles and tibia being carious. The greater part of the joint was obliterated by the existence of intra-articular adhesions, while in front of the femur there was a portion of synovial membrane which had undergone the gelatiniform change, thus illustrating the fact, which is familiar to surgeons who see many of these cases, that the gelatinous and the ordinary form of arthritis often coexist in the same case, and that, as regards their pathology, they differ in degree rather than in kind.

The convalescence of this patient after the operation was rapid and satisfactory. The wound united by adhesion, except at its extreme corners; the last ligature—only five were employed—dropped on the sixteenth day; the splint was removed for the first time during the sixth week, and, osseous union having occurred, was replaced by a pasteboard gutter about a week later. By the middle of May the patient was allowed to sit up, and in the latter part of the same month began to walk with crutches; in the beginning of June the pasteboard splint was exchanged for a simple soap plaster and bandage, and on July 3, one hundred and one days after the date of operation, the patient was discharged, cured, a photograph, from which the annexed wood-cut (Fig. 699) is taken, having been previously secured. At this time the wound was firmly healed, and the patient could walk without artificial assistance.



Result of excision of the knee-joint.

One of the most difficult excisions in its performance, and at the same time one of the most gratifying in its results, that I have ever met with, was that which was briefly related on page 560.

By a curious coincidence, two years afterwards, another lady of about the same age (32 years), and also a school-teacher, while visiting friends in West Chester, heard of the successful result in this case, and, consulting Dr. Massey in regard to her own knee, was by him sent to me. She had suffered from disease of the articulation in early childhood, and when she came under my observation had the joint fixed by bony ankylosis at an angle of less than 90° , so that she could only walk by the aid of a stilt-like support which she wore under her cloak. I operated upon her knee by Buck's method (excision in a block) on April 17, 1879, and she returned to her home in the following September, with a straight and firm limb, which has since constantly increased in usefulness. Her convalescence was delayed by profuse suppuration, and by the occurrence of secondary hemorrhage, without any obvious cause, during the third week after operation.

I have, in all, excised the knee-joint 26 times in 25 patients—one case was an example of re-excision—with 22 recoveries (one of these after amputation), 2 cases not terminated, and only 2 deaths. The particulars of all these cases are briefly included in the following table:—

TABLE SHOWING THE PARTICULARS OF TWENTY-SIX CASES OF EXCISION OF THE KNEE-JOINT FOR DISEASE OF THE ARTICULATION.

No.	Sex and age.	Nature of disease.	Duration of disease before operation.	Result; duration of treatment after operation.	Remarks.
1	Male, 10	Anchylosis and arthritis	Four years	Recovered; 5 months	Useful limb.
2	Female, 11	Arthritis	Six years	Recovered; 1 year	Useful limb.
3	Male, 18	Arthritis and abscess	One year	Recovered; 16 months	Useful limb.
4	Male, 9	Arthritis and abscess	Three months	Recovered; 4½ months	Useful limb.
5	Female, 9	Arthritis and anchylosis	Two years	Recovered; 20 months	Useful limb.
6	Female, 8	Gelatinous arthritis	Three years	Recovered; 13 months	Useful limb. See No. 24.
7	Male, 5	Gelatinous arthritis	Over two years	Recovered; 6 months	Useful limb.
8	Male, 6	Gelatinous arthritis	One year	Recovered; 5 months	Useful limb.
9	Male, 5	Gelatinous arthritis	About two years	Recovered; 1 year	Useful limb.
10	Male, 7	Anchylosis and arthritis	Two years	Recovered; 9 months	Useful limb.
11	Male, 28	Gelatinous arthritis	Three years	Recovered; 6 months	Amputation.
12	Female, 26	Arthritis and anchylosis	Nineteen years	Recovered; 3½ months	Useful limb.
13	Female, 30	Arthritis and anchylosis	Twenty-three yrs	Recovered; 6 months	Useful limb.
14	Male, 9	Arthritis and anchylosis	Over one year	Recovered; 15 months	Useful limb.
15	Female, 32	Anchylosis	Many years	Recovered; 5 months	Useful limb.
16	Female, 9	Gelatinous arthritis	Four years	Recovered; 10 months	Useful limb.
17	Male, 13	Arthritis and anchylosis	Six years	Recovered; 6 months	Useful limb.
18	Female, 6	Gelatinous arthritis	Four years	Died; 4 weeks	Death from septicæmic pneumonia, etc.
19	Male, 9	Gelatinous arthritis	Nearly two years	Recovered; 1½ years	Useful limb.
20	Male, 17	Anchylosis, etc.	Several years	Recovered; 3 months	Useful limb.
21	Male, 5	Gelatinous arthritis	Two years	Recovered; 10 months	
22	Female, 6	Anchylosis, etc.	One year	Died; 10 days	Death from double pneumonia.
23	Male, 6	Gelatinous arthritis	One year	Recovered; 1 year	Useful limb.
24	Female, 17	Anchylosis	Seven years	Recovered; 1 year	Useful limb.
			[years		Re-excision; See No. 6.
25	Male, 14	Gelatinous arthritis	Two-and-a-half	Still under treatment	Doing well.
26	Male, 40	Syphilitic arthritis	Several years	Still under treatment	Doing well.

In considering the applicability of the operation of excision in the treatment of disease of the knee-joint, I may put what I have to say in the form of answers to the following questions:—

(1) When should the surgeon abandon expectant measures in the treatment of knee-joint disease, and what may be considered the indications for a resort to operation?

(2) Operative interference having been resolved upon, how shall the surgeon decide between excision and amputation?

In order to give an intelligent answer to the first question, it is necessary to consider what are the prospects of recovery without operation, and what the condition of the limb is likely to be if such a recovery can be obtained. To no class of diseases is the maxim "*obsta principiis*" more applicable than to joint-affections, for if carefully treated from their beginning they seldom terminate badly. Of course I am not speaking now of *wounds* of joints, for these are always very serious injuries, and too often end, even under the most favorable circumstances, in the loss of life or limb. But, in their early stages, inflammatory affections of even the largest joints, whether following upon contusions or sprains, or of non-traumatic origin, are usually quite amenable to treatment. No doubt in some few cases there is such a constitutional predisposition to destructive bone-and-joint disease, that from a very slight cause very serious consequences may ensue: thus, many years ago, a boy was under my care, who, from a fall on the ice, received a contusion of the elbow, fol-

lowed in a few days by suppuration of that joint, and then by acute necrosis of the humerus and pyarthrosis of the shoulder, and whose life was barely saved by amputation at the shoulder-joint; but such cases are happily exceptional, and in a large majority of instances, if the patient can be at once put under careful and judicious treatment, a favorable result will follow.

But, unfortunately, these cases at first seem so trivial that they are too commonly neglected until the disease is far advanced. And so it happens that in many—perhaps half—of the cases of joint disease which are brought to our hospitals, the time has already past during which treatment, to be most efficient, should have been employed. Thus of the 26 cases of knee-excision embraced in my table, in only one had the disease lasted less than one year, the duration in the other cases ranging from one to twenty-three years. I do not deny that in some of these cases recovery might perhaps have been eventually obtained without operation, but what kind of recovery would it have been? We do, indeed, meet men and women hobbling about on crutches, with knees bent, and limbs withered and deformed, and such results may doubtless, in a certain sense, be called spontaneous cures; but what I maintain is that the limbs preserved by expectant treatment in these advanced cases of joint disease, are inferior to the limbs secured by the conservative operation of excision, and little, if any, better than no limbs at all.

I have dwelt upon this point at some length, because I believe that there are still many members of the profession who look upon excision of the knee-joint as a remedy of doubtful excellence, and who think that cases not bad enough for amputation should not be operated on at all.

In deciding whether an operation is required in any particular case of knee-joint disease, the surgeon must consider the age and general condition of the patient, the duration of the affection, and the stage to which it has advanced.

As regards *age*, no operation should as a rule be performed in cases occurring in very young children. No doubt in some rare instances the life of the patient may be in danger from the exhaustion produced by an inflamed and suppurating knee-joint, and in such cases the surgeon must choose the least of two evils, and remove the source of irritation by amputating the limb. But in the large majority of cases it is better to temporize, to put the part in as good a position as possible by straightening the limb, dividing tendons if necessary, and, as it were, patching up the joint, until the patient reaches an age when operative interference can be adopted with a better prospect of success. Excision of the knee is not a very successful operation in quite young children; these suffer more from confinement than those who are older, the restraint necessary during the after-treatment is more irksome to them, and they are, I think, more liable to the insidious development of tuberculous and other constitutional diseases. My own rule has been to postpone operation until the child has attained to at least the age of five—better nine or ten—years, and those cases which I have seen operated on by others at an earlier period of life, have usually done badly. Again, in persons past the middle age, unless amputation is positively required to rescue the patient from impending death, it is better as a rule to avoid operation. The mortality after excision is so great in these cases that prudent surgery would, it seems to me, under such circumstances, dictate rather to take the chances of a cure by the effects of nature, than to attempt to hasten recovery by operation.

The following table, compiled from Culbertson's figures, shows in a very satisfactory manner the mortality of knee-joint excision at different ages:—

TABLE SHOWING RESULTS OF EXCISION OF THE KNEE FOR DISEASE AT DIFFERENT AGES.

Age.	Total.	Recovered.	Died.	Result not determined.	Mortality per cent. of terminated cases.
Under 5 years . . .	19	11	7	1	38.9
Between 5 and 10 years . . .	106	88	17	1	16.2
“ 10 “ 15 “ . . .	99	81	18	...	17.2
“ 15 “ 20 “ . . .	84	58	25	1	30.1
“ 20 “ 25 “ . . .	67	40	26	1	39.4
“ 25 “ 30 “ . . .	55	34	20	1	37.0
“ 30 “ 40 “ . . .	65	38	27	...	41.5
Over 40 years . . .	19	9	10	...	52.6
Age not stated . . .	89	60	28	1	31.8
Aggregates . . .	603	419	178	6	29.8

The most favorable age for excision of the knee, as regards life, is from five to ten, but there is more risk than of consecutive shortening than at a later age, and the occurrence of bony union is obtained with more difficulty; hence the period of puberty is upon the whole that which may be considered to furnish the most favorable results.

In considering the *general condition* of the patient, when the question of operation arises, the surgeon must remember that these are essentially chronic cases, and that there can seldom be any justification for haste in operating, when by delaying a few weeks, or even months, the patient may be placed by constitutional and hygienic treatment in a more favorable condition to sustain whatever operation may be necessary. The presence of visceral disease, whether of the lungs or abdominal organs, must usually be considered a positive contraindication to excision, and under these circumstances, unless the local condition of the knee render amputation imperative, no operation should, as a rule, be performed. On the other hand, if the patient presents no evidence of visceral disease, and the general health seems to be directly suffering from the irritation arising from the diseased joint, the timely removal of the source of disturbance either by excision or amputation may prove the starting-point of rapid convalescence.

The *duration of the malady* must be considered by the surgeon in any case of knee-joint disease before deciding upon the propriety of an operation. I am not one of those who hold that a surgeon is bound invariably to wait a certain number of weeks or months to give, as is often said, a “fair trial” to other treatment before recommending an operation, for I believe that a thorough knowledge of the course and natural history of the disease will often enable him to say at once whether any particular case can or cannot be benefited by expectant measures. In their early stages, as I have before remarked, these knee-joint affections are quite amenable to treatment, and hence, putting out of the question some few cases of very rapid articular disorganization in which amputation is required, a judicious surgeon would in cases of recent origin endeavor to obtain, and would probably succeed in obtaining, a natural cure by placing the joint in good position, and at rest, by relieving intra-articular pressure by the use of continuous extension, and by combating the morbid process by careful constitutional and local treatment.

In a recent case, then, an operation can seldom be required; on the other hand, if the disease has lasted many years, the process of natural cure (such as it is) being pretty well advanced, and the patient perhaps past the age at

which excision would be likely to prove successful, the prudent surgeon will usually decline an operation, and content himself with straightening the limb either by gradual or immediate extension, then placing it at rest in a suitable splint, and simply aiding nature to complete the cure by ankylosis. But in the intermediate cases (and, as already remarked, these constitute a large proportion of those which come under the care of the hospital surgeon), when the disease has already lasted many months or even several years, and when from careful examination of the joint the surgeon is satisfied that its functions are permanently abolished, an operation may often be properly recommended as a means both of preventing suffering and of restoring the patient to active life more promptly than can be done by any other mode of treatment.

Even more worthy of consideration than the duration of the disease, is the *stage to which it has advanced*; and it is here to be remembered that the course of these joint-affections varies much in different cases. No operation is, as a rule, justifiable as long as the disease is limited to the synovial membrane, no matter how long the patient may have been affected; no prudent surgeon would recommend either excision or amputation in a case of mere hydrarthrosis. Nor even in a case in which all the tissues of the joint are evidently implicated should an operation be hastily recommended, as long as the integrity of the parts is maintained, and a hope remains that by subduing the inflammation the usefulness of the articulation may be preserved. But when the relaxed condition of the joint, and the occurrence of consecutive dislocation, show that the crucial ligaments and semilunar cartilages have disappeared; when the limb is contracted and helpless, and the patient gives a history of repeated relapses from comparatively slight injuries; or, on the other hand, when the doughy, semi-elastic character of the swelling shows the existence of gelatinous arthritis (the typical "white swelling" of the older writers), an operation may be properly resorted to even though the limb be at the time in a quiet condition. When in addition the joint is in a state of suppuration, and still more if there be caries of the articular surfaces, an operation may be considered (other things being favorable) as almost imperative.

In saying this I am not ignoring the fact that Mr. Haward and other British surgeons have applied mineral acids, and Mr. Fitzpatrick, of Dublin, the *potassa cum calce*, to the interior of diseased knee-joints, and have recommended these modes of treatment as substitutes for excision, as has Mr. Wright the laying open of the joint and scraping away the diseased structures. But the results of these methods have not been uniformly favorable, and excision has been found so satisfactory in my own hands that I have not felt tempted to abandon a tried and proved operation, for a procedure which at least has not as yet been shown to be an improvement.

It may be observed that in cases of *gelatinous arthritis*, an operation may be properly recommended at a comparatively early period; the reason for this is that in the gelatinous form of the disease there is commonly no tendency to a spontaneous recovery, and though in private practice, among the more wealthy classes, such a case may occasionally be brought to a favorable termination, in the class of patients met with in hospitals, a recovery without operation may practically be considered as out of the question.

The answer to the second question has of necessity been to a great degree anticipated in considering the first. The choice between excision and amputation must largely depend on the surgeon's belief as to the relative gravity of the two operations, and upon this point I have no hesitation in saying that I regard excision as a much more serious operation than the other. This is not a question to be decided by statistics (though I believe that if the com-

parison could be fairly made the result would be found in favor of amputation), for excision is habitually performed in selected cases, while all the rest are reserved for amputation.

And this is, indeed, the true point of view from which to look upon the question. The surgeon's first thought should undoubtedly be of excision—for when successful the result is immeasurably superior to the best result of amputation—but before deciding upon this operation he should weigh well all the circumstances of the case, the age and constitutional condition of the patient, the extent to which the bones entering into the articulation are affected, and the facilities which will be afforded by the patient's surroundings for conducting the after-treatment (often prolonged and wearisome) to a successful issue. If then the patient be neither too young nor too old, if there be no evidence of visceral complication, if the disease be sufficiently limited to allow of its entire removal without taking away so much bone as would materially impair the usefulness of the limb, and if the patient be so situated that the question of the time required for recovery is of secondary importance, the surgeon should choose excision, and by doing so will probably succeed in preserving for his patient a limb better than any artificial substitute, and in most cases better than could be obtained by the unaided powers of nature; under opposite circumstances, provided that the case is bad enough to require any operation, amputation should be resorted to, and the surgeon who employs it under such, and only under such, circumstances, will not have occasion to regret his decision.

Comparatively a successful operation when performed for chronic joint-disease, excision of the knee is a very grave procedure in cases of *wound* of the articulation, and is so fatal in cases of *gunshot injury* that it may fairly be questioned whether it should not be banished from military surgery. The figures bearing upon this point may be seen in the following table, compiled from the statistics of Gurit and Culbertson:—

TABLE SHOWING RESULTS OF EXCISION OF THE KNEE FOR INJURY AND FOR DISEASE.

Nature of case.	Total.	Recovered.	Died.	Result not determined.	Mortality per cent. of terminated cases.
Gunshot wound	146	33	111	2	77.1
Other injury	28	17	11	...	39.3
Disease	603	419	178	6	29.8
Aggregates	777	469	300	8	39.0

The result as to the *ultimate usefulness* of the preserved limb, in cases of knee-excision, is, in most cases, very satisfactory. Of the 9 cases of excision for gunshot wound, in Gurit's table,¹ the "end-result" was "very good" in 5, and "good" in 3; while the 17 recoveries after excision for other forms of injury, tabulated by Culbertson, gave 3 "perfect," and 11 "useful" limbs. My own list of 22 recoveries has given one amputation, one re-excision, and one doubtful case, leaving 19 in which the utility of the limb was assured, the permanence of the benefit derived having, in many of these cases, been verified years after the operation. The following summary shows the ultimate result in Culbertson's 603 cases of excision for disease:—

¹ See page 584.

Recovered without further operation	354 or 58.7 per cent.
Recovered with useful limbs	246 or 40.8 “
Died without further operation	166 or 27.5 “
Result undetermined without further operation	5 or 0.8 “
Recovered after subsequent amputation	65 or 10.8 “
Died after subsequent amputation	12 or 2.0 “
Result undetermined after subsequent amputation	1 or 0.2 “
Death-rate of terminated cases in which no further operation was performed	31.9 “

The *antiseptic method* is extolled by Ollier¹ in its application to excision of the knee, and he records 7 cases treated with antiseptic precautions, of which 6 ended in recovery, and 1 in death—apparently as the result of carbolic-acid poisoning. These results are not as good as those which I have myself obtained without any attempt to enforce Listerian measures. Ollier lays great stress upon the importance of preserving the periosteum and joint-capsule, making a small H-shaped incision in order to expose the bones, and additional lateral incisions for drainage. He takes particular pains not to divide the lateral ligaments, and, removing the patella, employs sutures not only to keep the sawn bones in apposition, but also to unite the tendon of the quadriceps femoris above to the ligamentum patellæ below. In traumatic cases, he advises that a single, longitudinal, median incision should be adopted, dividing the patella, which, under these circumstances, should not be removed. He attributes the first employment of the transverse section of the patella, as practised by Golding Bird, to Volkmann.

EXCISION OF THE PATELLA.—What is sometimes called *partial excision* of the patella—that is, gouging away its external surface—is an operation attended by no particular risk, and may be resorted to without hesitation in cases of caries or superficial necrosis affecting this bone; I have myself performed such an operation, in a case of syphilitic necrosis, with a favorable result. But when the *whole thickness* of the bone is removed, the knee-joint is necessarily implicated,² and the danger correspondingly increased. The operation may be required in cases of compound fracture, especially from gunshot injury, or of caries or necrosis. The bone may be conveniently exposed by means of a crucial incision. Heyfelder and Bœckel tabulate twelve cases, to which may be added others recorded by Knode, Wood, and Gay, and two cases referred to by Prof. Agnew as having occurred at the Pennsylvania Hospital. Of the whole 17 cases, 3 are said to have proved fatal, and 3 to have required subsequent amputation, while 11 terminated successfully.

RESECTION OF THE BONES OF THE LEG.—Resection of the *tibia* may be required in cases of irreducible compound fracture, ununited fracture, or fracture united with great deformity; and complete excision of the shaft of the bone has been successfully practised by various surgeons in cases of acute necrosis following subperiosteal abscess. The bone may be readily exposed by a longitudinal incision over its anterior, subcutaneous surface, supplemented, if necessary, by a short transverse cut. When the whole thickness of the tibia is resected, a corresponding disk must ordinarily be removed from the fibula, so as to allow union to occur without altering the axis of the limb. In cases of acute necrosis, however, the fibula is not interfered with, and the

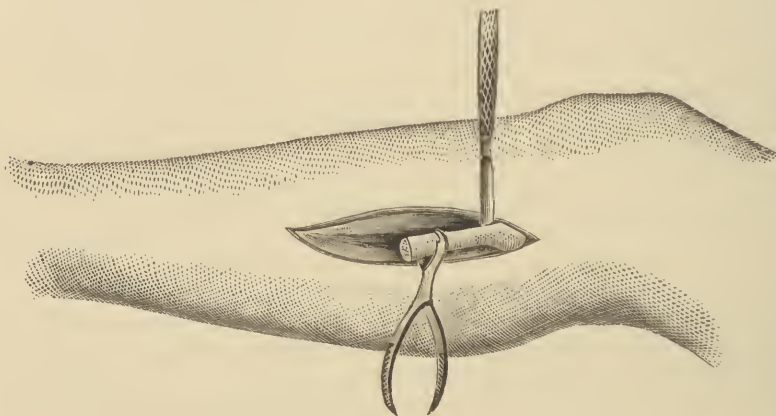
¹ Revue de Chirurgie, 10 Avril et 10 Mai, 1883.

² Bœckel, of Strasbourg, quotes a case in which Held removed the whole patella, in a state of necrosis, without opening the joint, which was walled off by a layer of granulations; such an operation is practically little more than a sequestrotomy.

tibial shaft is removed subperiosteally by dividing it with a chain-saw, and then wrenching either end from its epiphyseal attachment with the lion-jawed forceps.

The *fibula* may be resected with much less hesitation than the tibia, and, indeed, provided that the external malleolus is preserved, it may be entirely removed without materially impairing the usefulness of the limb. If the malleolus be lost, the foot is apt to become everted. A single longitudinal incision on the outer side of the limb, suffices to expose the bone, which is then divided with a chain-saw, and carefully separated from its attachments, the periosteum being, if possible, preserved. In excising the upper end of the fibula (Fig. 700) there is some little risk of opening the knee-joint, which,

Fig. 700.



Resection of upper end of fibula.

according to Lenoir, communicates with the tibio-fibular articulation once in ten times.

The results of these operations, except in cases of compound fracture, are quite satisfactory. On page 561 will be found a brief reference to a case of acquired deformity of the leg which I succeeded in remedying by a resection of both bones. The following table, borrowed from Heyfelder and Bæckel,¹ shows the result in 125 cases of leg-excision for various causes:—

TABLE SHOWING RESULTS OF EXCISION OF THE BONES OF THE LEG FOR VARIOUS CONDITIONS.

Nature of case.	Number of cases.	Recovered.	Complete success.	Incomplete success.	Died.
Fracture	65	47	43	4	18
False joint	11	11	10	1	0
Deformity of callus	16	15	14	1	1
Incurvation	11	11	11	0	0
Organic disease	22	20	19	1	2
Aggregates	125	104	97	7	21

¹ Op. cit., p. 22.

The next table shows the results of 387 cases in which resection of the leg-bones was performed during the late American war.¹

TABLE SHOWING RESULTS OF EXCISION OF THE BONES OF THE LEG FOR GUNSHOT INJURY.

Period of operation.	Total.	Recovered.	Died.	Undetermined.	Mortality per cent. of terminated cases.
Primary	215	148	67	...	31.1
Intermediate	87	58	29	...	33.3
Secondary	50	42	8	...	16.0
Unknown	35	27	4	4	12.9
Aggregates	387	275	108	4	28.2

The results in the treatment of compound fractures are thus seen to be far from encouraging; the mortality in civil practice being 27.4 per cent. and that in army-surgery 28.2 per cent., somewhat less, it is true, than the mortality of amputation in this locality, but proportionately higher when it is remembered that resection is an operation reserved for selected cases—for such as are considered to offer a prospect of preserving both life and limb.

EXCISION OF THE ANKLE.—Strictly speaking, this term should be limited to an operation involving the removal, partial or complete, of the tibio-tarsal articulation, and no more; but it is habitually applied by surgical writers to other and more extensive operations as well, to all ankle-joint excisions, in fact, even if supplemented by removal of the whole astragalus, or even of more distant bones.

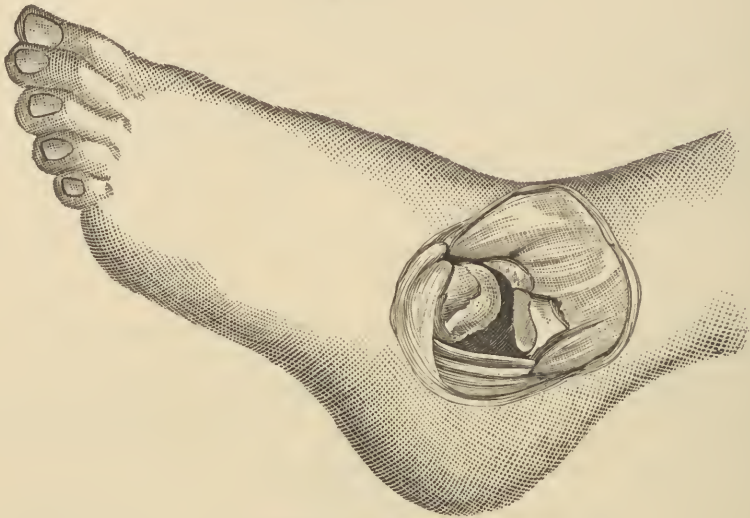
First performed by the elder Moreau, in 1792, this operation has never acquired great popularity at the hands of surgeons generally, many thinking it better, in cases requiring any interference, to amputate by Syme's or by Pirogoff's method. But while the stumps afforded by these procedures are most serviceable, they do not equal, either in appearance or in usefulness, the member preserved by a successful excision, and hence, in all suitable cases, the latter operation should, I think, be given the preference. It may be practised in cases of compound fracture or dislocation, as well as of chronic disease of the articulation.

Excision of the ankle-joint may be performed by means of two lateral incisions, one behind either malleolus, or, which I consider preferable, by means of a semilunar incision, made to pass around the lower border of the outer malleolus, and then continued longitudinally in the line of the fibula. (Fig. 701.) The anterior portion of this wound should not be prolonged so far as to risk the division of either the extensor tendons or the dorsal artery of the foot. The peroneal tendons having been severed, it is convenient, before going further, to remove the lower end of the fibula, which may be done either with cutting pliers or with a small saw. Polaillon divides the fibula with a chain-saw above the malleolus, leaving the latter attached to the bones of the foot, but there are some advantages in the ordinary method, as allowing more thorough examination of the astragalus. In traumatic cases, a partial excision, involving only the articulating extremities of the tibia and fibula, will often be sufficient, and in cases of disease, if the astragalus be but slightly affected, it will be enough to remove its upper sur-

¹ Medical and Surgical History, etc., Third Surgical Volume, page 875.

face with saw or cutting pliers, and then to apply the gouge and osteotrite to any softened or carious patches that may be found remaining. But under other circumstances the astragalus should be removed entire. The surgeon

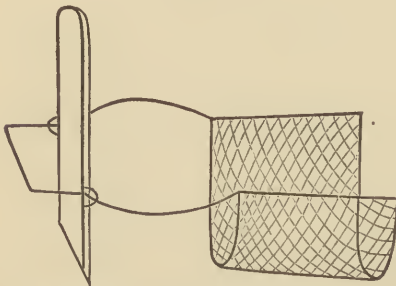
Fig. 701.



Excision of the ankle-joint.

next turns the foot inward, and, having carefully cleared the lower end of the tibia with the probe-pointed knife, cuts away the inner malleolus with strong forceps, and then removes as much of the tibia as may be thought desirable with the chain-saw, or, which I think preferable, as rendering the

Fig. 702.



Bracketed wire-splint for after-treatment of excisions of the ankle-joint.

operation easier, makes a second, short incision on the inner side of the limb, and then divides the tibia with a narrow-bladed saw, passed directly across from one side to the other.

During the after-treatment of ankle-joint excision, the limb may be kept in a fracture-box, or, which I prefer, in a bracketed wire splint such as is shown in Fig. 702. The foot must be kept well supported, lest a condition of acquired talipes equinus result. Fig. 703 illustrates the result in a case of partial excision of the ankle for compound fracture and dislocation, done in my wards at the University Hospital by my assis-

tant, Dr. H. R. Wharton. In two cases of chronic disease of the joint, in which I have resorted to complete excision, the patients did well as regarded their local condition, but died some months after the operation from pulmonary tuberculosis.

The statistics of ankle-joint excision have been investigated by several writers, including Spillman, Hancock, Poinso, Grossheim, Gurlt, and Culbertson. The last-named surgeon has collected¹ 124 cases of the operation as performed

¹ Op. cit., p. 297.

for *disease*, of which only 10 are known to have terminated fatally. The affection for which the operation was practised was in most cases arthritis or

Fig. 703.



Result of ankle-joint excision.

caries, but in some instances necrosis or bony tumor. The results may be seen in the annexed table:—

TABLE SHOWING RESULTS OF EXCISION OF THE ANKLE-JOINT FOR DISEASE.

Extent of operation.	Total.	Recovered.	Died.	Result not determined.	Mortality per cent. of terminated cases.
Partial excision	68	57	4	7	6.6
Complete excision	51	45	6	...	11.8
Not stated	5	5	...	...	...
Aggregates	124	107	10	7	8.5

The same author has collected¹ 154 cases of excision for *injury* (other than gunshot wound), and 45 cases in which *gunshot injury* was the cause of operation.² The results are shown in the following tables:—

¹ Ibid.
² The operation of excision of the ankle-joint appears to have been introduced into military surgery by Langenbeck, in 1859.

TABLE SHOWING RESULTS OF EXCISION OF THE ANKLE-JOINT FOR INJURY OTHER THAN GUNSHOT WOUND.

Extent of operation.	Total.	Recovered.	Died.	Result not determined.	Mortality per cent. of terminated cases.
Partial excision	147	126	19	2	13.1
Complete excision	7	7	...	...	0.0
Aggregates	154	133	19	2	12.5

TABLE SHOWING RESULTS OF EXCISION OF THE ANKLE-JOINT FOR GUNSHOT INJURY.¹

Extent of operation.	Total.	Recovered.	Died.	Mortality per cent. of terminated cases.
Partial excision	8	5	3	37.5
Complete excision	19	13	6	31.6
Not stated	18	15	3	16.7
Aggregates	45	33	12	26.7

Grossheim's figures, derived from the Franco-German war, are less flattering: 50 complete excisions gave 26 recoveries, 20 deaths, and 4 undetermined—a mortality of 43.5 per cent.; but, on the other hand, 47 partial excisions (including, however, operations on the tarsal bones) gave 33 recoveries and only 14 deaths, a mortality of but 29.8 per cent. Gurlt's figures embrace 150 cases, with 51 deaths, a mortality of 34 per cent.

The *utility of the limb* preserved by ankle-joint excision has been usually satisfactory. Culbertson tabulates² 177 good results out of 196, in which this point was inquired into, a proportion of more than 90 per cent. Gurlt's table of "end-results" in military surgery³ gives, out of 55 cases, 29 which were "good" or "very good," 23 which were "medium," and only 3 which were really "bad." Stauff, as quoted by Rose, gives the proportion of good results after excision of the ankle as 75 per cent.

EXCISION OF THE ASTRAGALUS.—This operation appears to have been first performed in 1582, by a surgeon of Duisburg, whose case, but not whose name, is recorded by Fabricius Hildanus. The astragalus may be excised when carious or necrosed, or in cases of compound fracture or dislocation. Simple dislocations may also prove an indication for the operation, if the displaced bone cannot be replaced, and if it threaten to produce sloughing by pressure upon the integument.

Excision of the astragalus may be conveniently effected by making a semi-lunar incision on the anterior and external aspect of the joint (Fig. 704). The removal of the bone may be rendered easier by first cutting across its neck with strong pliers, and then dislodging each fragment in succession with elevator and forceps, using the probe-pointed knife in the deep parts of the wound. In some cases, however, the bone has to be removed piece-meal by means of the gouge.

My personal experience in excision of the astragalus is limited to two

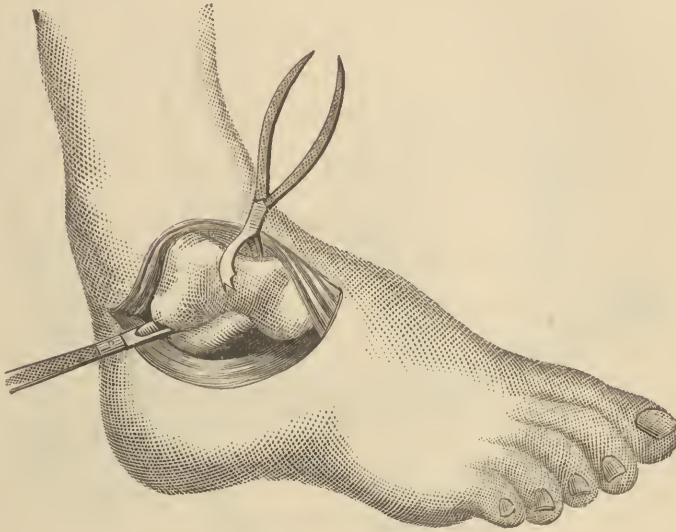
¹ See also tables on pages 558 and 559.

² *Ibid.*, page 302.

³ See page 584.

cases—one in which I successfully removed the bone, in a state of necrosis, following injury, in a man aged 49; and another in which I removed both

Fig. 704.



Excision of the astragalus.

astragalus and calcaneum, in an old man, for caries, the patient doing well for several months as regarded his local condition, but ultimately dying from pulmonary phthisis.

The statistics of excision of the astragalus have been particularly investigated by Hancock¹ and by Poincot.² The former author has collected 112 cases of total, and 28 of partial excision. Of the complete operations, 79 gave the patients useful limbs, 2 were followed by amputation, and 19 by death, the result in 12 cases not having been ascertained; the mortality of terminated cases was, therefore, 19 per cent. The partial operations gave 18 satisfactory recoveries, 8 less satisfactory or unknown results, and 2 amputations, of which 1 was followed by death. Poincot's table embraces 144 cases, of which 26, or 18 per cent., terminated fatally.

The joint between the astragalus and the calcaneum has been successfully excised by Mr. Annandale. [For Mikulicz's operation, see p. 647.]

EXCISION OF THE CALCANEUM.—This operation, which appears to have been first employed by Monteggia, in 1814, is sometimes required for the relief of caries or necrosis, though in the latter case the extraction of sequestra, and in the former free gouging, or Sédillot's operation of *évidement*, will ordinarily be sufficient.

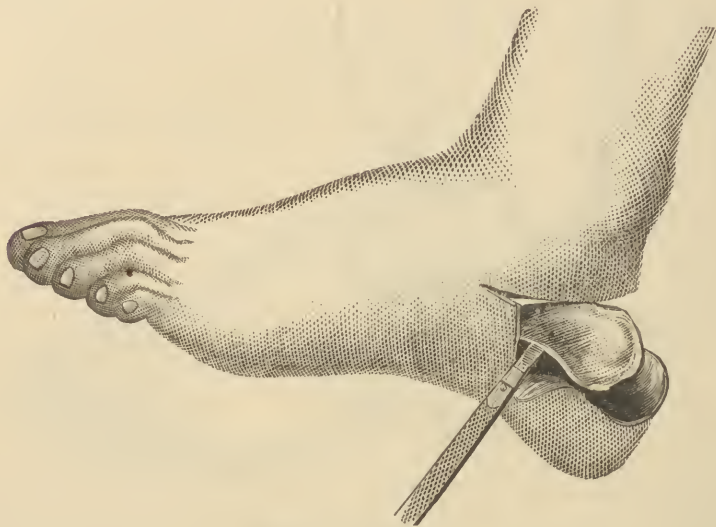
Various methods have been adopted for the excision of the os calcis. The plan of raising a heel-flap, as in amputation by Syme's method, is objectionable, as leaving a scar on the sole which may interfere with walking. Prof. Erichsen advises the turning down of an elliptic flap, constituted of the plantar tissues, and the formation of lateral, triangular flaps, by carrying a

¹ Operative Surgery of the Foot and Ankle-joint, pp. 265–268. London, 1873.

² De l'intervention chirurgicale dans les luxations compliquées du coude-pied, pp. 252–271. Paris, 1877.

longitudinal incision through the tendo Achillis to meet the first wound. Mr. Holmes's method seems to me preferable. In this mode of performing the operation (Fig. 705), an incision is made on the level of the upper portion

Fig. 705.



Excision of the calcaneum.

of the bone, beginning at the *inner* edge of the tendo Achillis (which it divides), and then passing around the back and *outer* surface of the foot, as far forward as a point midway between the heel and base of the fifth metatarsal bone. From near the anterior end of this incision, a second is made at right angles to it, passing downwards to the beginning of the grooved internal surface of the os calcis. A flap is thus marked out, which includes the cut peronei tendons, and which is then reflected from the bone; the ligaments of the calcaneo-cuboid joint are next divided, when the calcaneum itself can be slightly displaced *inwards*, thus rendering easier the division of the various ligaments which unite it to the astragalus. This having been accomplished, the bone is again twisted *outwards*, and cautiously separated from the soft tissues on its inner side. The calcaneum having been removed, a strip of oiled lint is placed in the cavity which is left, and the limb secured, with the foot at a right angle to the leg, by adjusting an anterior, moulded splint, or the bracketed wire splint recommended for the after-treatment of excision of the ankle.¹

Southam, of Liverpool, and Lund, of Manchester, have still further simplified the operation by making but a single external incision, beginning as in Holmes's method, and carried forward to a point midway between the tip of the malleolus and the projection of the fifth metatarsal bone.

Ollier's method consists in making an incision on the *outer* side of the tendo Achillis, extending from a point nearly one inch above the level of the tip of the external malleolus to the external tuberosity of the calcaneum; a second incision passes from the lower end of the first, along the outer side of the foot, to a point half an inch above and in front of the base of the fifth

¹ See Fig. 702. page 640.

metatarsal. These incisions are next deepened through the calcaneal periosteum, this membrane being separated, with the overlying tendons, from the bone, which is then seized and extracted after division of its astragaloid attachments. The tendo Achillis is not divided, but its insertion is pushed off together with the periosteum.

The subperiosteal method, judging from the report of a discussion upon the subject in the Clinical Society of London, does not appear to have met with much favor at the hands of British surgeons, and, indeed, according to Vincent's¹ statistics, which will be again referred to, it has been followed by a mortality almost the double of that which attends the operation when no attempt to preserve the periosteum is made. In many cases partial excision or free gouging, as by Sédillot's method (*évidement des os*), will prove sufficient, and when applicable should be preferred to extirpation. The result of such an operation, performed by Dr. Wharton in my wards at the University Hospital, for carionecrosis following frostbite, is shown in Fig. 706.

The statistics of this operation have been studied by Burrall,² of New York, and by Polaillon³ and Vincent,⁴ of Paris. The last-named surgeon has collected 79 cases, to which may be added 6 additional (successful) cases recorded by McGuire and Poore, giving a total of 85, of which but 5 are known to have terminated fatally.

Total number of cases, 85.

Recovered, with useful limb, 55, or 64.7 per cent.

Recovered, but without much use of limb, 5, or 5.9 per cent.

Amputated, 10, or 11.8 per cent.

Died, 5, or 5.9 per cent.

Result undetermined, 10, or 11.8 per cent.

Mortality of subperiosteal cases (3 out of 23), 13 per cent.

EXCISION OF THE ANTERIOR TARSAL BONES.—The tarsal bones, other than the astragalus and os calcis, rarely admit of excision, their diseased conditions, when too far advanced for successful gouging, commonly necessitating amputation. I have, however, myself, on a few occasions, removed one or

Fig. 706.



Result of partial excision of os calcis. The patient had also lost his toes by frostbite, but had, nevertheless, a very useful foot.

¹ De l'ablation du calcaneum, etc. Paris, 1876.

² Bellevue and Charity Hospital Reports, p. 91. New York, 1870.

³ Archives Générales de Médecine, Sept. et Oct. 1869.

⁴ Op. cit.

more bones of the tarsus, the most extensive operation of this kind in my own experience having been the successful excision, in a young child, of the scaphoid, three cuneiforms, and the base of the first metatarsal. Dr. Conner, of Cincinnati, who is the chief apostle of tarsal excisions in this country, has twice successfully removed the *entire tarsus*, and a third operation of the same character, also successful, has been reported by an English surgeon, Mr. H. M. Jones. No positive rules can be given for the excision of the anterior tarsal bones; the lines of incision must be decided by the position of existing sinuses, care being taken of course to avoid unnecessary division of tendons. Dr. Conner¹ has succeeded in collecting no less than 108 cases of tarsal excision of various kinds, the gross mortality having been but a little over 10 per cent.

Total number of cases, 108.

Recovered, with very good use of limb, 45, or 41.7 per cent.

Recovered, with good use of limb, 23, or 21.3 per cent.

Recovered, with fair use of limb, 6, or 5.5 per cent.

Recovered, but with failure as regards use of limb, 10, or 9.3 per cent.

Recovered, but uncertain as regards use of limb, 12, or 11.1 per cent.

Result undetermined, 1, or 0.93 per cent.

Died, 11, or 10.18.

Of 31 cases of tarsal excision for gunshot injury, tabulated by Drs. Otis and Huntington,² 25 recovered and 5 ended fatally (16.6 per cent.), the result in one instance being undetermined. (See page 647.)

EXCISIONS OF THE METATARSAL BONES.—The bones of the metatarsus may require excision in cases of caries or necrosis, and in some cases of compound fracture, usually as the result of gunshot injury. The lines of incision must be mainly decided by the position of existing sinuses, but it may be said generally that, for the first metatarsal (Fig. 707), the incision should be

Fig. 707.



Excision of metatarsal bone of great toe.

placed on the inner side of the foot, and for the fifth on the outer side, while the others may be approached from the dorsum. These operations, as those on

¹ American Journal of the Medical Sciences, Oct. 1883.

² Op. cit. Third Surgical Volume, page 622.

the carpus, may be much facilitated by previously rendering the part bloodless by Esmarch's method, the wound after the operation being stuffed with oiled lint, and a compress and firm bandage being applied before the removal of the restraining tube. Of 57 cases of metatarsal excision tabulated by Drs. Otis and Huntington, 46 ended in recovery and 8 in death, the result in 3 being undetermined. The mortality of terminated cases was thus less than 15 per cent.

EXCISION OF THE METATARSO-PHALANGEAL JOINTS.—The articulations between the metatarsal bones and phalanges are seldom excised, injuries or diseases of these joints which require any operation usually demanding amputation. Even in cases of neglected bunion, followed by caries, ablation of the whole toe and head of the metatarsal bone will, I think, commonly be found the best remedy, though complete excision of the joint has under these circumstances been successfully practised by numerous surgeons, including Kramer and the elder Pancoast, and partial excision by others, such as Hueter, Hamilton, Gay, of Buffalo, and A. Rose, who recommends the operation even in cases of simple contraction (*hallux valgus*) without caries. If excision is to be practised, the joint, in the case of the great toe, is to be exposed by a longitudinal incision on the inner side of the foot (Fig. 708), and in the case of the fifth toe by a corresponding wound on the outer side.

Fig. 708.



Excision of metatarso-phalangeal joint of great toe.

EXCISION OF THE PHALANGES OR INTER-PHALANGEAL JOINTS OF THE TOES is **not** a procedure that can be recommended. Should operative interference be demanded at all, in affections of these parts, amputation should be resorted to.

OSTEOPLASTIC RESECTION OF THE FOOT.

Under the above name, Mikulicz describes an operation which may be regarded either as a modification of Pirogoff's amputation, or as a partial excision of the tarsus. An almost precisely similar operation is said by Sklifosovsky to have been performed by Wladimiroff, of Kazan, as early as

1872. As practised by the last-named surgeon, an incision is first made across the sole of the foot, penetrating to the bones on a level with the middle of the scaphoid and cuboid; from the extremities of this, other incisions are carried up laterally to the tops of the malleoli, and a final transverse incision, just above the tuberosity of the calcaneum, unites the lateral wounds, and lays open the ankle-joint from behind. The foot is next disarticulated, care being taken in separating the anterior tissues not to wound the dorsal artery, and a second disarticulation is effected in the line of Chopart's amputation at the medio-tarsal joint. Finally, the posterior halves of the scaphoid and cuboid are removed with the saw, as are the malleoli and the articulating surface of the tibia. The remaining front portion of the foot is then brought up so that its dorsal surface forms a straight line, continuous with the anterior surface of the leg; the bones are fixed in their new situation by means of wire sutures; the wound is closed and dressed antiseptically; and the leg and foot are held in position with anterior and posterior plaster splints. Mikulicz's operation differs from that above described, merely in the fact that he does not apply sutures to the bones.

The effect of this operation is to give the patient a limb resembling that of *pes equinus*, and to enable him to walk on the resisting ball of the foot, with the toes in a position of extreme extension. It is of course applicable to cases in which the lesion involves only the posterior part of the foot, and which would ordinarily be treated by amputation in the lower part of the leg.

This operation appears to have been employed successfully in some twenty or more cases, by various surgeons, including, among others, Dr. Fenger, of Chicago, and Dr. Hopkins, of Philadelphia. Its "end-results" have not, however, as yet been sufficiently studied to enable us to say whether it is really preferable to the supra-malleolar amputation which it is meant to replace. Mikulicz has devised a special boot for the patient to wear on the affected foot, and, as the leg of this side is made by the operation somewhat longer than its fellow, an ordinary high-soled shoe may be worn upon the sound foot.

EXCISION OF THE KNEE-JOINT.

BY

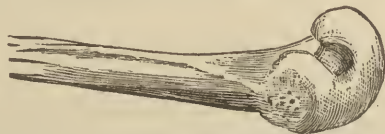
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PROFESSOR OF SURGERY IN M^CGILL UNIVERSITY; SURGEON TO THE MONTREAL GENERAL HOSPITAL.

I SHALL in the following pages describe the method of excising the knee-joint which I have myself invariably practised. In all the cases that have come under my own observation I have adopted the single incision in the soft tissues, and have invariably found it sufficient for the purpose.

An incision is made extending from the back part of one condyle of the femur, passing across the front of the joint to the back part of the condyle on the opposite side of the limb. This should be carried below the lower part of the patella, and curved slightly downwards. This incision should divide the ligamentum patellæ and also both lateral ligaments. The joint is thus freely opened; the soft parts, with the patella included, are now reflected upwards, and on flexing the leg upon the thigh, the lower end of the femur will protrude through the wound. The crucial ligaments, if intact, should be divided close to their attachments, and the soft parts freely separated from the intercondyloid notch. In doing this the edge of the knife, guided by the finger, should be kept close to the bone, so as to avoid injury to the popliteal artery, which lies in close proximity to the bone near its centre, and is separated from it only by some fat, occasionally one of the deep lymphatic glands, and some areolar tissue. The whole articular surface can thus at once be brought into view, and its condition observed. It can now be removed with the saw. I have been in the habit for some years past of removing the extremity of the femur with a fine fret-work saw, which I have had adapted to Butcher's frame. By a circular sweep from the front, extending backwards, the operator can take away just so much of the bone as is involved in the disease. If the bone is in process of ulceration, or softened, a second

Fig. 709.



Convex surface of lower end of femur after the application of the saw.

thin slice may be removed. The operator should be careful in making this section to remove an equal length of both condyles, which will enable him to adjust the bones with greater accuracy, and will prevent the tendency to bending of the limb to either the outer or the inner side. By removing the end of the femur after the manner above described, the sawn extremity presents a rounded surface. A thin slice from the face of the bone will, as a

general rule, be sufficient; all the disease present, and the entire cartilaginous surface, can be taken away without any unnecessary sacrifice of substance. The importance of this will be at once apparent: if the operation be in a child, the epiphyseal line will not be encroached upon, and the subsequent growth of the bone will not be arrested; if in an adult, the shortening of the limb will scarcely be noticed. The next step in the operation is to clear away the soft parts of the head of the tibia. If, as is so frequently seen, there exist pulpy thickening of the synovial membrane, or much gelatiniform infiltration of the soft parts, this can with advantage be removed. It must be regarded as diseased tissue, is of low vitality, and will, if left, tend to break down, and to delay the subsequent closing of the wound. The head of the tibia having been cleaned, the saw may be applied. In removing the head of the tibia the section should be made from behind forward, rendering it concave. With

Fig. 710.



Concave surface of the head of the tibia after the application of the saw.

care, this can be done with such accuracy as to fit it for the reception of the rounded extremity of the femur; a thin slice is usually sufficient, but if, as is sometimes seen, the bone is in a condition of caries, a second slice can be taken away in the same manner.

The bones should be accurately adjusted. If it be found that they do not fit nicely, they can be made to do so by taking away another thin slice from either bone, or the rounded extremity of the femur can be reduced with a good, sharp cartilage-knife; thus successive slices can be removed, care being taken not to go beyond the epiphyseal lines. If the case be one in which there has been no previous distortion, such as dislocation backwards of the bones of the leg from neglect of position in the early treatment of the disease, the bones will now come readily together in the straight position. If, on the

Fig. 711.



The bones fitted together.

other hand, difficulty be met with from shortening of the hamstring tendons, these may be divided subcutaneously, or a further section of the bones can be practised. Division of the hamstring tendons should, if possible, be avoided, as it is liable to complicate the case; suppuration is very apt to result, and pus would be likely to follow up the sheaths of the tendons, and give much trouble.

The patella has next to be dealt with, and should be removed. Some surgeons have left the patella, taking away a thin slice from its posterior surface; this has been done with the object of giving strength to the union of the bones in front. It is quite possible, under favorable circumstances, for this

to occur, but it is quite as likely for the bone to become necrosed, necessitating its removal at a later date, and thereby delaying union. Nature has intended the patella to act as a protection to the front of the joint, and also to give greater leverage power to the quadriceps-extensor muscle; but by removal of the knee-joint the usefulness of the patella is lost, and to leave it behind would serve no good end. Another question of practical interest is whether anything is to be gained by leaving behind the investing sheath of the patella. I have in all my own cases removed the patella, in some cases shelling it out of its bed like the kernel of a nut. I think that leaving the sheath is objectionable, for the reason that nothing is gained by doing so; as it acts as a periosteum, the vessels entering the bones are minute and numerous, and, being in fibrous tissue, great difficulty is experienced in stopping their bleeding; again, a cavity is left, which, after the limb is put up, fills with a clot of blood. In some of my cases the oozing from these vessels has been considerable. In the last three or four cases operated upon I have removed the patella and its investment, and have had much less trouble as regards hemorrhage.

In contemplating the method of section of the bones, as above alluded to, it will be observed that they become locked as it were, the one into the other; in this position they are held by the muscles. As long as the bones remain in this relative position, it will be found that there is no chance of displacement; indeed, I have experienced difficulty in separating them when the patient has slightly recovered from the anæsthetic. After removal of the joint, and of the tags which are sometimes found in the wound, all bleeding points should be secured. This is a matter of great importance to the subsequent success of the case; sometimes the vessels are very minute and very numerous, so that the bleeding is rather a general oozing than a hemorrhage from any vessel that can be ligated. Under these circumstances the application of hot carbolic lotion will be found of advantage. I have on several occasions packed the wound with sponge saturated with hot carbolic lotion, drawn down the flap, and proceeded to apply the splint, and have found on removal of the sponge, for the purpose of closing the wound, that nearly all bleeding had ceased.

Various forms of apparatus are at the disposal of the surgeon, all having one object, to retain the parts at rest sufficiently long to favor union of the soft parts as well as of the bones. This absolute rest should be combined with freedom from restraint. The apparatus should afford support to the limb, and at the same time should permit change of dressings, and removal of the patient from place to place, as occasion may require, without disturbing the bones.

The apparatus which has seemed to me to answer the purpose better than any other, is that designed by Dr. Patrick Heron Watson, of Edinburgh. There are many advantages to be claimed for its use in dressing the limb after excision of the knee-joint. It is simple in construction, easy of application, and always at hand, and it admits of the application of dressings to the wound without disturbance or removal of the splint, thereby adding materially to the comfort of the patient, and permitting careful cleansing of the part. In speaking of the splints devised by Mr. Butcher and others, Dr. Watson remarks, that he found them "inconvenient and irksome in the last degree to both patient and surgeon." He also draws attention to their unfitness for preventing displacement of the thigh, which is sure to occur "in proportion to the restlessness of the patient." And he says, "the displacements of the thigh I found, as described by every operator, to be of two kinds: rotation in a direction outwards, and abduction with a slight degree of projection forwards. These displacements, I furthermore found, could not be

overcome when they once had occurred, without giving great pain, and without the complete re-application of the apparatus.¹

It is advantageous to fix the limb in the splint before closing the wound. By so doing the surgeon can readily rectify any little displacement of the bones that may occur during the application of the splint, as he has the parts constantly under observation.

I can fully bear out the claims put forth by Dr. Watson in favor of the apparatus which he has designed for the treatment of excision of the knee-joint, and I cannot do better than quote from his work a description of the apparatus: It consists essentially of two parts: (1) A suspension-rod made of iron or steel, extending from the groin to the extremities of the toes; at the ankle-joint it is bent at an angle to the outline of the foot, and over the situation of the knee it forms a bow or arch. To the upper surface of the rod are riveted one or more hooks, by which the limb can be suspended from the running pulley of a Salter's swinging eradle. As an improvement, I have had attached to the under surface of the bar two square pieces of tin, one

Fig. 712.



Modification of Watson's front splint.

situated at the upper part, three inches below the groin, the other over the upper surface of the leg; these give additional firmness, and do not add materially to the weight. They prevent the bar from being displaced or twisted during its application. (2) The second part of the apparatus is made of a Gooch's splint, specially prepared, the laths being somewhat thicker than those ordinarily employed. The splint can be cut out to fit the limb; it should not be too wide, but sufficiently so to surround about two-thirds of the limb's circumference. Laterally, it should be cut out on either side opposite the situation of the wound, leaving a sufficiently broad shelf to give support to the popliteal space. The inferior extremity of the splint is made of the shape of a horse-shoe or stirrup, sufficiently wide to admit the foot, this being supported by the two projecting pieces which pass down on each side of the malleoli. In this way the heel is protected from pressure, and the foot held firmly and amply supported. Dr. Watson gives two forms of back splint,

Fig. 713.



Back splint fitted to limb.

either of which may be selected. In one, at its outer part, the splint is left a little long and rounded, so as to adapt itself to the os innominatum, to

¹ Excision of the Knee-Joint, page 17. Edinburgh, 1867.

which it is attached by adhesive straps. This splint should be well padded with cotton-batting or lint, and covered with gutta-percha tissue. The manner of applying this apparatus is as follows: I shall describe the method pursued in our hospital, which differs in some minor points from that described by Dr. Watson. I have been in the habit of using paraffine, and find that it is quite sufficient to give support, and I think it superior in many respects to the plaster of Paris as recommended by Watson.

Fig. 714.



Back splint without outside piece.

The bones are carefully adjusted, and, while the limb is held in position by an assistant, a light flannel bandage is applied from the toes to just below the wound. A similar bandage is applied to the thigh, from above the wound to as high as the groin. This is done for the double purpose of giving support to the circulation, and also of protecting the limb from the effects of the hot paraffine. The posterior splint is now applied with a gauze bandage soaked in the hot paraffine. This gives considerable firmness, but, before the paraffine consolidates, the position of the bones should be ascertained, and, if they are in the least degree out of position, the disarrangement must be remedied. The anterior splint should now be applied, and retained in position by gauze bandages, soaked in the same way as before. When these are sufficiently consolidated, the edges of the wound are brought together by interrupted wire-sutures with intermediate sutures of carbolized catgut. A large-sized drainage tube is introduced at each angle of the wound, passing in sufficiently far to insure free discharge. If, as is sometimes the case, oozing goes on, a large soft sponge may be placed over the wound, and retained in position by a bandage of antiseptic gauze. Two strips of lint soaked in paraffine, and allowed to cool, are now placed around the edge of the splint, close to the exposed skin, so as to prevent blood or discharge of any kind from passing beneath the splint. The wound is then dressed after the manner of Lister, the eight-ply dressing completely encircling the limb and splint, passing beneath the arch of steel, and extending above and below the wound to about a hand's breadth on either side.

The operation and subsequent application of the splint should be conducted under the spray. In all the last fifteen cases treated, the splint was not removed until the soft parts had united, and in some not before complete and satisfactory bony union had been obtained. In the subsequent dressings, the spray should also be used. In several of the cases here alluded to, union of the soft parts progressed without any suppuration, and in some the amount of pus was inconsiderable. The great object is to maintain perfect and absolute rest; by this I mean absolute fixity of the bones, and but slight disturbance of the soft parts—not more than occurs in passing a sponge over the face of the wound, to remove any discharge that may be there. For the first few days the dressings may require to be changed frequently. It is seldom that they demand removal before the end of 24 hours, but if the oozing of blood and serum be very great, and the dressings become soaked, they should be changed sooner. The apparatus being applied with gauze bandages and paraffine, and a good layer of paraffine covering all, the discharge has no

tendency to trickle beneath the splint, thereby soiling the flannel bandage and giving discomfort to the patient. The drainage tubes should at each dressing be removed and cleansed; if this be not done, drainage will not be thoroughly maintained, the tubes very soon becoming blocked up; they may with advantage be clipped off at each dressing, and by gradually shortening them, the process of union will be favored. The wound may be syringed out, if there is anything likely to offend, which does not flow away; but, as a rule, the less the parts are disturbed the better. It is very objectionable to disturb or separate the flap from its bed by injecting forcibly an antiseptic lotion of any kind. This I have seen done, and have always regarded it as hurtful. We must believe that union is progressing; and to disturb a wound with any fluid will do no good, but, on the contrary, will in all likelihood separate and tear the delicate structures, and retard the process of cure. As the discharge in many cases is very inconsiderable, it would be far better to discard the use of the syringe altogether, and simply wipe away any matter that requires to be removed with a sponge or piece of lint. The drainage tubes ought to be removed when the surgeon believes that they have done all that they are expected to do. There is as much error in maintaining the drainage tubes too long *in situ*, as there is in doing without them altogether.

The wire sutures do not require to be removed for a considerable time, as they create very little disturbance. I have been in the habit of leaving them undisturbed until perfect union of the soft parts has been obtained. The cat-gut sutures seldom, if ever, require to be removed, as the deeper portion is absorbed, and that outside can be readily wiped away. The surgeon must be ever on the alert for the presence of pus. Should any collection form, from pus being retained in the meshes of the cellular tissue, it should be freely opened. Nothing can lead to greater disaster in surgical cases than pent-up pus, and in the after-treatment of excision of the knee-joint the greatest care and watchfulness should be exercised to guard against the occurrence of any such complication.

The apparatus of Dr. Watson appears to answer the requirements better than any other that I have myself used, or have seen in use. It was to me a matter of regret, in the treatment of my earlier cases of excision of the knee-joint, that no suitable splint had been suggested, and in reading over Dr. Watson's book on this subject, and viewing his illustrations, I must admit that I still doubted the practical utility of the apparatus suggested. It was chiefly with the hope of gaining increased steadiness between the ends of the bones that, in 1868, I designed and carried out section of the bones in the way above described.¹ I had experienced the benefit of this method with the use of an iron splint, a modification of that used by Sir W. Fergusson, and the results were satisfactory in giving greater steadiness between the bones, and a subsequently straight and well-shaped leg. Having obtained such favorable results, I naturally felt some reluctance in adopting any novelty, however strongly recommended.

Dr. Watson's apparatus was first used by me in 1878, and all the cases operated on in the Montreal General Hospital since that date have been put up in the same manner, with some slight change, according to circumstances, such as substituting paraffine for the plaster of Paris. The advantages to be claimed for this form of splint are: greater steadiness between the bones and greater comfort to the patient, permitting free motion of the body without disturbance or alteration in position of the bones at the point of section. The confinement becomes less irksome, and there is less risk of the occurrence of

¹ Canada Medical Journal, vol. vii., page 318, 1871.

bedsores. It is evident that bedsores are liable to form in patients held down in one position for weeks together; any change in the position of the body—any movement, however slight—is always grateful to a patient after an operation. Dr. Watson has pointed out that the various splints in use will permanently fix the leg and foot, but that the thigh-bone has a constant tendency to rotate outwards; the buttocks will sink into the bed, and the patient will, through sheer discomfort, rest on the outer side of the thigh, thereby seriously altering the axis of the bone. Before using this apparatus, the want of steadiness between the bones was a constant source of anxiety, and to prevent bedsores, I had been in the habit of having the patient raised from his bed, and, while held up, having his back carefully bathed and cleansed, and thoroughly dried, and having him replaced on a freshly-prepared bed. This was an ordeal greatly dreaded by the patient, although performed with great care, and with the help of many assistants. With Watson's apparatus, however, aided by suspension of the limb, there is such firmness, with freedom of motion, that I have seen patients, before the end of the first week, able to sit up with comparative comfort; and in attending to the calls of nature they have been able to swing themselves out of bed, and get on to a close-stool or chair placed at the bedside. The advantage to the *morale* of the patient will also be apparent.

In putting up the limb after excision, the surgeon may employ plaster of Paris, or paraffine, or a combination of both plaster and paraffine—this is a mere matter of choice. The plaster makes a firmer splint—it is heavier—but from absorbing the discharges it soon becomes foul; moreover, when the spray is used in dressing the wound, should it be necessary to repeat the dressing frequently, the plaster will soften down and be less efficient. To obviate all these disadvantages the plaster may at the outset be coated over with paraffine, or else paraffine may be employed without plaster; it is quite strong enough, and forms a lighter splint; it is always sweet and clean; any discharge of blood or serum, or of pus, will trickle away, and will be taken up by whatever dressing is applied to the wound. The front splint, if made of steel and if fitted beforehand to the limb, will bind and keep the parts in very accurate apposition. In its construction it should have one or two hooks; one, as shown in the engraving, Fig. 712, is all that is really necessary, and this is used for the purpose of suspending the limb in a Salter's swinging cradle. This contributes greatly to the comfort of the patient.

With respect to closing the wound, I have been in the habit of leaving this to the last, and I think with advantage. The bones during the application of the splint should be under the charge of the surgeon or of an assistant, whose duty should consist in preventing any displacement of the bones after their adjustment, even to a slight degree. When once the plaster or paraffine has set, there is no chance of displacement: the wound can now be closed, the edges brought accurately together, and perfect drainage secured at both angles. The gauze dressing should then be applied, and in applying it that portion of the splint which supports the popliteal space must necessarily be included. This method has been adopted in all my recent cases, and I have had no reason to regret its employment. It is well not to disturb the wound by too frequent dressings; but, again, to leave it too long without a change, is an error in the opposite direction. I am not so pronounced a Listerite as to believe it necessary to change the dressing as soon as any discharge shows itself on the outside of the eight-ply wrapper. Of course if it should be abundant, sufficient to soil or soak into the draw-sheet, and should be still soaking through and draining away, I should deem it advisable, for the sake of comfort to the patient, to change and cleanse the wound; but if, as in some cases, serum alone had come away, and had dried, and were not giving evidence of being very considerable,

nor, by affecting the temperature, of creating any irritation, I should leave the limb at rest. In this particular I am impressed with the advantage of watching scrupulously the temperature chart; any rise in temperature indicates some local irritation, if not threatened suppuration; and if this continues for several days together, it is, in my opinion, a sure indication of the presence of pus. In some of my later cases, very few changes of the dressings were required; in Case No. 27, of the Table, that of a young girl, the dressings were changed five times only; complete union of the soft parts was found to exist, and the antiseptics were discontinued, on the 23d day from the date of operation. The splint, however, was not removed until the thirty-fifth day.

TABLE OF TWENTY-EIGHT CASES OF EXCISION OF THE KNEE-JOINT.

No.	Sex and age.	Condition of joint.	Duration.	Result.	Shortening.	Days in bed.	Operator.
1	M. 18	Chronic disease from injury	7 years	Recovered	1½ inches	70	Dr. Fenwick.
2	M. 22	Chronic disease from rheumatic inflammation, partial ankylosis	9 years	Recovered	2 inches	56	Dr. Fenwick.
3	M. 23	Partial ankylosis in bent position. Arrest of growth of bones in length	9 years	Recovered	4½ inches	154	Dr. Fenwick..
4	M. 14	Chronic disease.....	10 years	Doubtful ¹	2 inches	.....	Dr. Fenwick.
5	M. 16	Complete ankylosis at a right angle	10 years	Recovered	3 inches	125	Dr. Wright.
6	M. 42	Chronic disease.....	.....	Amput'd ²	.....	.....	Dr. MacCallum
7	M. 36	Chronic disease from injury	5 years	Amput'd ³	.....	.....	Dr. Fenwick.
8	F. 21	Chronic disease.....	5 years	Recovered	1½ inches	84	Dr. Fenwick.
9	M. 22	Chronic disease.....	3 years	Recovered	2½ inches	136	Dr. Drake.
10	M. 19	Chronic disease.....	4 years	Recovered	2 inches	56	Dr. Fenwick.
11	F. 12	Chronic disease with backward dislocation, partial ankylosis in bent position	7 years	Recovered	3 inches	212	Dr. Fenwick.
12	M. 38	Chronic disease from injury	5 years	Recovered	2 inches	98	Dr. Fenwick.
13	M. 17	Chronic disease.....	2 years	Died ⁴	.....	30	Dr. Fenwick.
14	F. 26	Chronic disease from injury	14 years	Recovered	1½ inches	54	Dr. Fenwick.
15	F. 28	Chronic disease with suppuration following pleuropneumonia	13 years	Recovered	1¼ inches	60	Dr. Fenwick.
16	M. 15	Chronic disease, ankylosis at right angle	3 years	Recovered	2 inches	34	Dr. Roddick.
17	M. 18	Chronic disease following rheumatic arthritis	8 years	Recovered	1½ inches	52	Dr. Fenwick.
18	M. 22	Chronic disease.....	8 years	Recovered	.....	131	Dr. Roddick.
19	M. 12	Chronic disease from injury	2 years	Recovered	1½ inches	36	Dr. Fenwick.
20	F. 24	Chronic disease.....	4 years	Recovered	1½ inches	28	Dr. Fenwick.
21	M. 27	Chronic disease from injury	14 years	Recovered ⁵	1½ inches	.....	Dr. Fenwick.
22	F. 11	Chronic disease from injury	4 years	Recovered	½ inches	41	Dr. Fenwick.
23	M. 12	Chronic disease.....	6 years	Recovered	1½ inches	73	Dr. Roddick.
24	F. 11	Chronic disease, ankylosis at right angle	3 years	Recovered	1½ inches	72	Dr. Roddick.
25	M. 16	Chronic disease from injury	11 years	Recovered	1½ inches	65	Dr. Fenwick.
26	F. 5	Chronic disease from injury	2 years	Recovered	1 inch	62	Dr. Roddick.
27	F. 21	Disease from cold, and subsequent fall	6 years	Recovered	¾ inch	39	Dr. Fenwick.
28	F. 23	Chronic disease from injury	3 years	Recovered	½ inch	36	Dr. Fenwick.

¹ Patient taken to the country by his friends; results not hopeful.

² No union of bones; the patient insisted on having the leg amputated.

³ Partial union of bones. Contracted smallpox. Extensive suppuration, necessitating amputation.

⁴ Died from pyæmia.

⁵ Splint removed thirty-ninth day, firm union; allowed to get up; goes out on gallery.

ORTHOPÆDIC SURGERY: THE TREATMENT OF DEFORMITIES.

BY

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HISTORY OF ORTHOPÆDIC SURGERY.

ORTHOPÆDIC SURGERY forms an important section of surgical science: it deals with distortions and contractions of the head, trunk, and extremities, affections which differ widely in their nature, and vary much in their method of development; its study includes a consideration of lesions of the muscular and nervous systems, and of diseases and injuries of the bones, joints, fasciæ, and skin; nor is this the limit of orthopædic practice, for a disordered condition of one or all of the processes of respiration, circulation, and digestion, may in some cases be present as a complication, whilst mental disturbance may give rise to, or be itself caused by, a condition of deformity. The classification of such different affections under one heading is apparently unscientific, but the cause of this grouping is made evident when the history of orthopædic surgery is traced.

The treatment of deformities has been practised since the earliest days of surgery, but their effective relief has only been achieved within a comparatively recent period; until the end of the last century the only method of practice pursued was the employment of mechanical appliances, which was attended by a very small measure of success. The first advance in the direction of a more scientific mode of procedure was made by Thilenius, in 1784, who advised, and under whose direction was performed, section of the tendo Achillis in a case of talipes varus; the operation, which consisted in the free division of the tendon by an open wound, was followed by a good result. In 1804, Sartorius divided the same tendon in a boy aged thirteen, who was suffering from talipes equinus consequent upon the formation of an abscess in the calf of the leg; the operation was commenced by making an external wound four inches long, and after some dissection of the parts the tendon was divided; further dissection was considered necessary on account of adhesions existing between the tendon and adjacent tissues, and, finally, forcible manipulations of the ankle-joint were practised. This operation, it is not surprising to read, was followed by great pain and constitutional disturbance, but the boy recovered with his foot in an improved position, though with an ankylosed ankle-joint. Delpech, too, in 1816, treated a case of talipes equinus by section of the tendo Achillis, dividing this tendon by making two lateral incisions about one inch in length, and leaving the superficial tissues at the back of the tendon intact; this operation was followed by suppuration and sloughing of the tendon, which, although a fairly good result was ultimately obtained, probably deterred Delpech from again adopting such a method of procedure. This surgeon appears to have so far profited from his experience

that he saw the necessity of modifying his plan of operating, and he gave, in a work published in 1828, this advice: "the tendon to be divided should not be exposed; its section should be made by a *détour*, and not by an incision parallel to that of the skin;" but the rule thus prescribed was never practically carried out by Delpech, so that although he first theoretically counselled subcutaneous tenotomy, it remained for Stromeyer to perform and introduce the operation. The great advance in the method of dividing tendons which Stromeyer devised, consisted in making the external wound a mere puncture; Delpech, in the rule above quoted, speaks of the wound made in the superficial tissues as an *incision*, so that although Stromeyer was no doubt to some extent assisted to the discovery he made by his predecessor's theoretical advice, yet his evolution of subcutaneous tenotomy must have been chiefly the result of original thought. Dr. Little gives the following translation of Stromeyer's description of the operation of dividing the tendo Achillis:¹—

The operation must invariably be effected by puncture without external incision. A small, moderately curved, sharp-pointed bistoury is adapted for most occasions. The limb should be extended in order to produce the necessary projection of the tendon, when the instrument should be passed behind it, the point perforating the opposite skin; division of the tense resisting tendon being effected rather by pressure of the edge than by its slow and cautious onward movement. The skin, being elastic, yields to the pressure of the knife, the two punctures not exceeding its width. I have frequently divided the tendo Achillis in this manner without producing a second puncture; but this is of little moment, as two minute punctures heal as quickly as a single one. The division of the tendon is known by an accompanying sound, which can scarcely be mistaken. The performance of the operation with the point of the instrument is less to be relied on, partly from its being too weak, and also because the operator can be less certain of not causing injury to other structures in the event of the patient not remaining quiet throughout the operation. . . . The attempt to commence extension directly after the operation, and the endeavor immediately to restore the limb to its natural position, which will very seldom succeed, and, as the case of Sartorius proves, can only be effected by great force, is neither necessary nor advisable. The commencement of extension before cicatrization of the wound in the integuments is unadvisable even when possible, as it may produce inflammation and suppuration not confined to the vicinity of the wound; it is unnecessary, inasmuch as the tension of the divided muscle is not restored during the gradual mechanical extension applied subsequently to the healing of the wound, but occurs after the complete reunion of the tendon, and after the necessary motions of the limb during exercise have acted as a stimulus to its contractility.

Stromeyer's operation, although at first received with some opposition, was soon established as a safe and reliable mode of treating club-foot. Dieffenbach, of Berlin, adopted subcutaneous tenotomy with much enthusiasm, and the practice was also followed by Duval, Bouvier, and Guérin, of Paris, Scoutetten, of Strasbourg, and other continental surgeons. In England, section of the tendo Achillis was performed by the late Mr. Whipple, of Plymouth, in the year 1836, but he appears not to have repeated the operation, and the case resulted in nothing further than enabling this gentleman to lay claim to a priority of performance of the operation amongst his countrymen. With Dr. Little rests the honor of introducing subcutaneous tenotomy to his professional brethren in England; Dr. Little himself, having the misfortune to suffer from deformity of the foot, at once appreciated the value of Stromeyer's method of treatment, and hastened to place himself under the eminent German's care. Greatly benefited by the treatment, Dr. Little remained to study Stromeyer's practice; on returning to England, in 1837, he laid before the profession the valuable results of his experience, and chiefly by his efforts was a special hospital for the practice of orthopædic surgery established in London.

¹ Treatise on the Nature of Club-Foot. London, 1839.

The introduction of subcutaneous tenotomy by Stromeyer was followed by results which can scarcely be estimated at too high a value. No sooner was it found that the treatment of club-foot had at last been undertaken upon scientific principles, than surgeons began to direct their attention to other forms of contraction and distortion, and the operation of subcutaneous tenotomy was applied with success in cases which had before been considered incurable, and the treatment of which had been relegated to the quack and empirical machinist. Like all other discoveries, subcutaneous tenotomy was at first employed somewhat recklessly, but this want of appreciation of its capabilities was soon corrected, and laws for its fitting performance were established by the investigations and labor of many able men. The mechanical appliances previously in use were discarded or improved, and the machinist's ignorance of the anatomy of the deformity which he endeavored to remedy by his ill-contrived appliances, was reformed by the science of the surgeon. From subcutaneous tenotomy sprang that still greater field of practice, general subcutaneous surgery, which, although not limited to the treatment of cases of deformity, was, together with a corrected knowledge and improved use of mechanical apparatus, the foundation of the special branch of practice called orthopædic surgery. Orthopædic surgery then, if it is to be considered a separate section of our science, is a specialty of treatment; it confines its therapeutic benefits to no one organ of special sense or function, nor indeed to one special class of cases; for although it deals with the treatment of deformities, all deformities are not brought within its range—such for instance, as hare-lip, cleft-palate, and spina bifida—because the treatment of these affections does not belong to subcutaneous surgery.

The treatment of the various conditions of contraction and deformity which we have now to consider, is a subject full of interest to all surgeons; few greater benefits can be conferred upon suffering humanity than that given by the removal of distortion—an affliction which, whatever may be its particular nature, is most distressing to its unhappy subject, both physically and mentally. One attribute belongs peculiarly to this branch of practice and lends to it especial interest: the practitioner is almost entirely compelled to rely upon his own care and resources in obtaining a satisfactory result; he has not simply to place the affected part in a favorable condition for nature to effect the cure, but, on the contrary, he has by constant attention to combat opposing forces until a complete restoration to the normal state, if such be possible, has been gained—a termination to the case which can only be arrived at by careful attention to details and established rules of practice. Orthopædic surgery cannot yet be described as a perfect art, but this much may be allowed: that, as far as our knowledge goes, it is an exact science, and that the surgeon who has studied its practice with a reasonable amount of care, may confidently assure himself that he knows to what extent he can relieve any particular condition of deformity which he may have to encounter.

The conditions of deformity, the treatment of which pertains to orthopædic surgery, as has already been noticed, differ widely in their nature, and it may be further remarked that they vary much in the relative frequency of their development; three thousand consecutive cases which have passed under the writer's personal observation were constituted as follows:—

Deformities of spine	937
Club-foot	581
Curvature of the bones of the leg	743
Genu valgum	526
Other deformities of lower extremity	158
Deformities of upper extremity	42
Wry-neck	13

CLUB-FOOT.

The term club-foot was at first applied to only one form of distortion of the foot, but it now includes several affections which present marked differences of character; for these affections Dr. Little suggested that the generic term *talipes* should be employed, and this nomenclature is now universally adopted, the deformities being classified in four groups under the names of *talipes equinus*, *talipes calcaneus*, *talipes varus*, and *talipes valgus*. The characteristic features of each of these varieties of deformity are well defined, and clearly distinguish the different groups; thus, the subject of distortion being in the erect position in *talipes equinus*, the forepart only of the foot touches the ground, the heel being raised and not used in progression; in *talipes calcaneus* the front of the foot is raised and the heel only affords support; in *talipes varus* the outer border of the foot is on the ground, and the inner border is turned upwards and inwards; in *talipes valgus* the outer border is raised, and the inner side of the foot is depressed. A verbal description of these four conditions of *talipes* indicates that the first two, *equinus* and *calcaneus*, present opposite points of deformity, and that the last two, *varus* and *valgus*, differ in the same manner; this is to some extent true, but beyond the fact that the shape of the foot assumed in the respective conditions of *equinus* and *varus*, is so far different from that obtaining in *calcaneus* and *valgus*, that in the former cases the part of the foot which touches the ground is in the latter the part which is raised, and *vice versa*, the various deformities possess no other points for comparison, and each must be considered as a separate subject and be studied independently. A further elaboration of the grouping of the various forms of *talipes* has also been adopted by classifying certain combinations of these deformities which not unfrequently occur; thus there are described *talipes equino-varus* and *equino-valgus*, *calcaneo-varus* and *calcaneo-valgus*—distinguishing titles which are justified by clinical facts; it will, however, be more convenient for description to keep to the simple forms, and consider the different combinations according as the chief characteristic of distortion represents *equinus*, *varus*, *calcaneus*, or *valgus*.

The development of club-foot depends upon numerous *causes* which differ considerably in their mode of action; certain of these productive influences may be exercised on the fœtus, giving rise to one or other of the forms of *talipes*, and the etiology of congenital deformity will have to be considered when *talipes varus*, which is by far the most common variety of congenital club-foot, is described. The non-congenital or acquired forms of *talipes* almost invariably originate in disturbance of the nervous system, and in consequent excitation of muscular abnormality. When this muscular abnormality coexists with non-congenital club-foot, it presents itself under two conditions which differ widely from one another. In one state the muscles are tense, firm, and well developed, but they do not properly respond to nervous influence, and their action is therefore ill-regulated. In this condition of the muscles, which is called “spastic contraction,” the fibres have become permanently shortened and have lost the power of normal extension—a result which is generally due to their having been thrown into violent action through reflex irritation of the motor nerve-system in early life. The various affections which give rise to convulsions in early childhood, may, any one of them, leave this state of permanent muscular contraction; thus, the eruption of the teeth, intestinal irritation, due either to the presence of entozoa or to the administration of improper food, and exposure to cold, are all exciting causes of spastic contraction, while the same condition is also frequently developed in

infants born before the full period of gestation is completed, and in those whose period of birth has been normal, but in whom, from prolonged labor or other causes, the performance of the processes of respiration and circulation has been delayed. The contraction of the muscles excited in such cases is most probably dependent upon reflex irritation of the motor nerves through the sensory or sympathetic systems, and not upon lesion of the nerve-centres; that the stimulus is reflex, is beyond doubt in the conditions first named, such as teething, etc., in which local irritation is present, whilst in the case of infants prematurely born, the irritation of the nerves is to be accounted for by the demand made upon tissues not yet perfected, to fulfil the functions which are necessary for a separate existence.

When spastic contraction affects the muscles of the leg and foot, deformity is very sure to occur, the progressive formation of which will have to be considered when describing the different varieties of club-foot. It must be remarked that deformity of the foot is not the only distortion that arises from this tonic muscular spasm, the result of nerve irritation; any part of the body liable to the same influence may become distorted, but for convenience of description this fact may be disregarded for the present, and attention may be directed merely to the condition of foot-distortion. Accompanying the local muscular disturbance there is not unfrequently present a defective condition of the intellect; children who are subjects of this affection are nearly always slow in learning to talk, although they may readily understand what is said to them; they are dull and stupid, and in the more severe cases they may be semi-idiotic.

The other state of muscular degeneration which has been referred to as one of the chief causes of non-congenital deformity of the foot, is of quite a different character from that just described. The muscles are to a greater or less degree wasted, and their tissue is softened; their contractile power is diminished or altogether lost, and they consequently either act feebly, or fail entirely to respond to the nervous stimulus. This affection of the muscles results from a lesion of the nerve-centres, that somewhat obscure affection which attacks children at about the age of from one to three years, and which is commonly known as *infantile paralysis*. The clinical history of this disease is well known: that it is often insidious in its onset, being ushered in by no premonitory symptoms; or again that slight feverishness may precede the attack; or that it may be the sequel of scarlet fever, measles, whooping-cough, or other exhausting disease. Paralysis more or less complete of the muscles of the extremities, the onset of which is remarkable for the suddenness of its appearance, is the chief characteristic of this disease. The attack is usually limited to one side of the body—the leg, and it may be also the arm on the same side, being affected; the muscles of both legs may however be paralyzed, or the leg on one side and the upper extremity on the other may be simultaneously attacked. The paralysis varies greatly in degree, from a slight loss of muscular power, which passes by unnoticed, to complete loss of muscular power; sensation is not impaired, the lesion being limited to the motor nervous system. There is much difference in reference to the liability of the separate muscles to become influenced by the disease; all the muscles of the leg may be affected, or the paralysis may affect only single muscles or groups of muscles; and even when the attack is general in its effects, the degree of paralysis is nearly always greater in some muscles than in others, those which especially suffer being the extensors of the toes (flexors of the foot) and the *tibialis anticus*. The seat of mischief in this disease is central, and consists, as far as we are acquainted with the nature of the malady, in a lesion of the motor centres of the spinal cord; but we are not in possession of evidence to account for the fact that the motor centres are affected in such a

manner as to induce paralysis of certain muscles much more frequently than of others.

These two conditions of nerve-lesion and muscular disorganization are the chief causes of non-congenital club-foot; I have made no endeavor to describe the nature of these diseases, as a full discussion of them would be impossible without encroaching on space required for matter with which this article is more directly concerned; all that has been attempted is to draw attention to these sources of deformity, and further elucidation of the subject must be sought for in the works of authorities on disorders of the nervous system.

The order most convenient to follow in describing the varieties of club-foot, will be to take talipes equinus first, and then talipes varus, since the latter deformity is frequently combined with the former; next talipes valgus will follow, and finally talipes calcaneus. The development of one or other of these deformities is of sufficiently common occurrence to make them all of importance to the surgeon; of the 581 cases of distortion of the foot already referred to, 151 were examples of equinus, 206 of varus, 175 of valgus (including flat-foot), and 49 of calcaneus; as a congenital deformity varus is by far the most common, but as a non-congenital deformity equinus is most frequently met with.

Before describing the various forms of club-foot in detail, a few general remarks may be made upon the operation of *tenotomy*. Section of a tendon should only be employed when contraction of the affected muscle is confirmed, but when this state has become established, tenotomy is the only means by which it can be relieved. The knife should be entered at a little distance from the side of the tendon, and on a level with its superficial surface; it should then be pushed downwards, with its flat side directed towards and touching the tendon, until the deep surface of the latter is reached and the blade is well beyond it; the cutting edge is then turned, and the section of the tendon is made towards the skin. As small a knife as possible should be selected, but the steel must be strong and well-tempered; the shape of the blade is of no particular importance, and the surgeon may consult his own convenience in this respect. When the knife is withdrawn, the puncture is sealed with a pad of lint and a piece of strapping; repair is then carried on without the occurrence of unhealthy inflammation. The process of repair consists in the exudation of lymph between the cut ends of the divided tendon; the investigations of Adams¹ have clearly shown that it is from this new material alone that the new tendon is formed, and that any blood that may be present is absorbed and does not become organized; the lymph is chiefly supplied by the connective tissue which forms the sheath of the tendon. The presence of nuclei and nucleated cells is the first step in the organization of the new material; capillary bloodvessels are next formed, and elongation of the nuclei takes place; the lymph soon presents a fibrillated appearance, and in the course of time becomes distinctly fibrous in structure. The new portion becomes fused with the old tendon in such a manner that it is scarcely possible to distinguish between them, the only difference being that the former is somewhat translucent, and of a slightly grayish color.

TALIPES EQUINUS.—Talipes equinus is so called because the deformed foot presents some resemblance in shape to the foot of a horse; the simplest form of distortion occurs as a congenital affection, when from contraction of the extensor muscle of the foot the heel is raised and the toes are pointed downwards. Congenital equinus is very seldom met with; but Little and Adams have both recorded cases, so that all doubts, and such have been expressed,

¹ On the Reparative Process in Human Tendons. London, 1860.

as to the occurrence of this deformity at birth, are set at rest. The cases quoted by Dr. Little are of especial value, since in two instances the subjects were the sons of a surgeon; the eldest child of the family was affected with the deformity, and was treated with success by Dr. Little, and the youngest and eleventh child was also born with equinus, which, although not of a severe grade, was sufficiently marked to necessitate the employment of mechanical treatment for its relief. A case of congenital equinus has never come under my own notice, but on page 675 (Fig. 723) will be found an illustration of equino-varus existing at birth, and in which the complication of varus was very slight indeed—only sufficient to warrant the classification of the case as one of equino-varus and not of simple equinus.

Paralytic Equinus.—The most common form of non-congenital talipes equinus results from paralysis of the extensor muscles of the toes, the peculiar liability of which muscles to become affected in infantile paralysis has already been alluded to. The condition of the foot in this particular form of the affection will be found to vary according to the nature of the muscular defect; Fig. 715 illustrates the external appearances presented in one variety of the distortion. In this case the foot was extended to an extreme degree upon the leg, the heel was raised, and the dorsum was directed forwards and slightly downwards; such a condition results from complete paralysis of the flexor muscles of the foot, the power of flexion being thus lost, and the foot falling into the position of full extension. When the cast of the foot, from which this drawing is copied, was taken, the paralysis had existed for about four years, during which time no recovery of the affected muscles had taken place; and from the unbalanced action of the gastrocnemius and soleus muscles the heel had become raised, and the foot extended much beyond the normal degree. It will be noticed that the toes were directed somewhat backwards, and that the arch of the foot was unnaturally deep; in walking, the foot became folded up so that the front of the toes and part of the dorsum of the foot were placed on the ground, and, had the deformity remained unrelieved, the foot would gradually have become retroverted on the leg, the sole being directed upwards and backwards, and the dorsum of the foot turned directly downwards. The condition of equinus here represented is the least common variety of the paralytic affection; as a rule, the flexor muscles partially regain their power of contractility, or they are not completely paralyzed when first attacked, in which cases the foot presents different characters of distortion. The partial restoration of the extensor longus digitorum and proprius pollicis muscles, causes the toes to be drawn up towards the dorsum of the foot as shown in Fig. 716; the parts of the foot which then reach the ground are the ends of the metatarsal bones and the extremities of the toes, and on the surface of the skin corresponding to the ends of the metatarsal bones, the cuticle becomes hardened and thickened to much the same condition as that of the normal heel. The weight of the body is carried directly through the foot, and from the pressure thus thrown upon it the arch becomes greatly deepened, and the sole of the foot is much shortened. This shortening of the foot is entirely a mechanical process, and is not due to active contraction of the muscles and fasciæ of the sole, although these tissues acquire a condition of confirmed contraction from their points of attachment being brought abnormally near to one another. The establishment of this feature of the deformity is clearly shown in Fig. 716, where

Fig. 715.

Paralytic equinus;
complete paralysis.

another important character of the distortion is also illustrated; from the partial recovery of the anterior muscles, the extensors of the foot are to some degree antagonized, so that the heel is not drawn up to the same extent that it is in the condition of persistent paralysis illustrated in Fig. 715. If the forepart of the foot, in front of the astragalus and os calcis, is hidden from view, the heel will be found to be in its normal position; therefore, if the distortion of the foot itself, the shortening of the sole, and the contraction of the toes, were removed, the patient would be able to stand well on the plantar surface of the foot. If allowed to continue unrelieved, this con-

Fig. 716.



Paralytic equinus; partial recovery of anterior muscles.

Fig. 717.



Paralytic equinus; severe stage of same deformity as shown in Fig. 716.

dition of deformity passes on to a state of great severity; the continued pressure on the arch of the foot still further increases the shortening of the sole, as is shown in Fig. 717, and the forepart of the foot, which touches the ground, spreads out and becomes abnormally wide. In this case there is on the dorsum of the foot a marked prominence at the seat of the calcaneo-cuboid and astragalo-scaphoid articulations (the transverse tarsal joint), arising from the bones in the front of the foot becoming depressed, and from the head of the astragalus being exposed and projecting forwards on the dorsum.

Spasmodic Equinus.—*Talipes equinus*, the result of spasmodic contraction, differs in some important respects from the paralytic variety of the deformity, the chief feature being that the distortion of the foot itself is not as severe. The extensor muscles of the foot are especially liable to become affected with spastic contraction, from irritation of the nerve-centres during infancy, and a gradual shortening of the gastrocnemius and soleus muscles, with contraction of the tendo Achillis, occurs. This contraction is increased when the subject uses the muscles in walking, and thus it often happens that a child in whom the shortening is not sufficient to prevent the foot from being fairly flexed on the leg, when examined with the muscles at rest, is yet unable to place the heels on the ground when walking; from this state the contraction

may gradually increase until the foot can only be brought to a right angle with the leg, and still further, until a confirmed condition of extension of the foot to a greater or less degree is established. The character of this deformity is well shown in Fig. 718, which exhibits an extreme degree of spasmodic equinus; the foot is fully extended upon the leg and the heel is raised, the toes are drawn up, and the arch of the foot is somewhat increased in depth; this case is illustrated in Mr. Adams's work on club-foot,¹ from which the drawing here given is copied. This case should be compared with that of paralytic equinus, Fig. 716; in both the same part of the foot is placed on the ground, and the toes are drawn up to much the same extent, yet the differences in the distortion of the two feet are very marked. In the spasmodic variety the heel is raised, in the paralytic it is in its normal position; in the former the foot is but slightly shortened, in the latter the sole is much contracted; in both the phalangeal extremities of the metatarsal bones are somewhat widened, and the forepart of the foot is abnormally broad. This variation in the nature of the two conditions of equinus, is due to the limb affected with paralysis being wanting in vitality in all its constituent parts: the bones are small, both in length and circumference; the fibrous tissue of the ligaments is defective in tenacity; the skin is livid, and in cold weather purple in tint—all these defects being due to malnutrition and insufficient blood-supply. In spasmodic equinus no such general wasting occurs; there is increased contractility of the affected muscles, and there the mischief ceases; the structures of the foot are therefore better able to bear the weight of the body than are the weakened tissues of the paralyzed limb.

Other Forms of Equinus.—Talipes equinus occasionally results from other causes than those already described. A very similar condition to that of spasmodic equinus arises from local irritation of the extensor muscles of the foot; a wound or other injury of the calf, the formation of abscess in the same situation, reflex irritation of the muscles from rheumatic or other inflammation of the ankle-joint, may all be exciting causes of the deformity. Equinus may also arise from a wound of the anterior tibial nerve giving rise to paralysis of the flexor muscles of the foot; it may also be purely mechanical in its origin, as when the foot is kept for a long period in the extended position and permanent shortening of the extensor muscles becomes established; again, extensive ulceration of the skin, or a severe burn, on the back of the leg, may induce the deformity. Such conditions must be regarded as spurious forms of the distortion; but a knowledge of the pathology and treatment of the typical conditions of equinus will greatly assist the surgeon in the management of such cases.

Treatment of Talipes Equinus.—In entering upon the treatment of a case of talipes equinus, the surgeon has first to satisfy himself as to the original cause of distortion, and next to determine how far the deformity consists of changes in the shape of the foot itself, and what alteration has occurred in the normal relationship of the foot to the leg. The three characteristics of equinus have been noted as widening of the forepart of the foot, shortening of the sole with contraction of the plantar fascia, and elevation of the heel; of these three conditions, the former never exists without the two latter being present, and only occurs in cases of severe deformity of some years'

Fig. 718.



Spasmodic equinus. (After Adams.)

¹ Club-Foot, its Causes, Pathology, and Treatment; 2d edition. London, 1873.

standing, while the two latter may exist together or separately. The relative degree to which the three conditions are present in any case, depends upon the original cause of the deformity, and upon the length of time that it has existed. In equinus the result of paralysis, the characteristics of the deformity will be determined by the nature of the disturbing influence in the initiatory nerve-lesion; when paralysis of the anterior muscles is complete and persistent, the foot falls to a state of extreme extension, which is increased by contraction of the gastrocnemius and soleus muscles; accompanying such a condition there may also be general loss of power of the muscles of the lower extremity, to such an extent that the subject has no power to use the leg in walking or standing; a crutch is used, and the foot is never subjected to pressure from having to bear the weight of the body, and the deformity does not advance beyond the stage of abnormal extension of the foot upon the leg. When the limb is used, the progress of the deformity in these cases of extreme paralysis consists in folding backwards of the forepart of the foot in the manner already described; distortion of the foot is then added to the extension at the ankle-joint. When after the paralytic attack the flexors of the foot retain some power of contractility, the condition of equinus-development will be of the nature illustrated in Figs. 716 and 717; in such cases the principal feature of deformity is the change in the shape of the foot itself. In spasmodic equinus, where contraction excited in the extensor muscles is the immediate cause of distortion, and where the foot is from its inherent strength able to support fairly well the pressure to which it has to submit, the extension of the foot on the leg is the most prominent symptom, and only in long-standing cases do shortening of the sole and widening of the metatarsal bones take place. The following tabular statement of the various stages of paralytic and spasmodic equinus, will perhaps render clearer the points to be observed in deciding upon the course of treatment to be adopted for relief of the deformity.

PARALYTIC EQUINUS.*Early stage.**Advanced stage.*

Slight loss of power of flexor muscles.

Partial falling of foot, with slight contraction of tendo Achillis.

Slight contraction of plantar fascia and deepening of arch of foot. Tendo Achillis very slightly if at all contracted.

Greater loss of power of flexor muscles.

Considerable falling of foot, drawing up of toes, and inability to flex foot beyond a right angle.

Considerable deepening of arch, and contraction of plantar muscles and fascia; widening of forepart of foot; heel slightly raised.

Complete loss of power of flexors of foot.

Extreme extension of foot on leg, with elevation of heel.

Forepart of foot folded backwards, and dorsum placed on the ground; heel raised. If general paralysis of lower extremity exists, the foot remains as in first stage.

SPASMODIC EQUINUS.*Early stage.**Advanced stage.*

Slight contraction of extensors of foot.

Achilles tendon slightly contracted; heel raised an inch or so in walking, but foot can be flexed when muscles are at rest.

Foot can only be brought to right angle with leg; heel much raised when walking. Slight contraction of sole of foot.

Severe contraction of extensors of foot.

Increased contraction of tendo Achillis. Foot can only be flexed to a right angle when leg is at rest.

Heel much raised, and walking powers very defective; contraction of tendo Achillis very marked; arch somewhat deepened, and forepart of foot widened.

To relieve the deformity of the foot, the measures of treatment that may be resorted to are of three kinds: mechanical treatment, which consists in the use of various instruments intended to bring the foot to its normal shape;

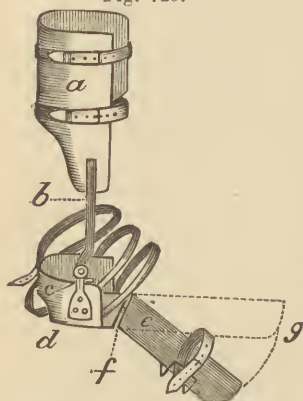
operative treatment, which involves the subcutaneous division of contracted tissues; and physiological treatment, as it is called, which is the employment of manipulative exercises, shampooing, galvanism, and other allied processes. In the several conditions of equinus, these methods of treatment, one or all, are employed according to the nature of the existing distortion. Taking first a case of paralytic equinus, with partial recovery of the anterior muscles, and the foot in the condition represented in Fig. 716, the treatment to be adopted for the relief of the deformity, which is one of the type most commonly met with, must be directed to remedy the distortion of the foot itself, and to overcome any obstacle that may exist to the free movement of the foot upon the leg. The distortion of the foot consists chiefly in a displacement of the scaphoid and cuboid bones from the astragalus and os calcis, the anterior part of the foot being in fact partially dislocated from the posterior at the transverse tarsal joint; this displacement is maintained by acquired contraction of the plantar fascia, and possibly also by shortening of the superficial muscles of the sole of the foot. Movement at the ankle-joint is restricted by some contraction of the Achilles tendon, and also by want of use; in such cases the foot cannot be flexed beyond the right angle, or this movement may be still more limited. The chief characteristic of deformity is the distortion of the foot proper, and to reduce this must be the first object of treatment, the relief of the impeded movement of the ankle-joint being attempted afterward. This course of action is pursued because the fixing of the os calcis, and with it the astragalus, is of great help to the surgeon in using measures for reducing the distortion of the foot; for, just as in the case of a dislocated limb, he thus obtains an immovable base on which to return the displaced parts; if, on the contrary, the mobility of the ankle-joint be first restored, the want of stability of the posterior bones will render the reduction of the distorted foot a very difficult task, if not an impossibility.

The first step in treatment is to overcome by *subcutaneous section* the contraction of the tissues in the sole of the foot, and care must be exercised to ascertain what is the amount of structural shortening present; it is not always possible to decide this point with exactness, for the tightened superficial tissues may hide the contraction of deeper structures. The sole of the foot must be put on the stretch by fixing the heel and forcing forwards the forepart of the foot, when the greatest resistance to extension will usually be found to be at the inner border of the plantar fascia; in order to discover the full degree of contraction, the nail of the fore-finger should be pressed against the inner edge of the tightened band, as though trying to hook around it, and should be pushed up into the sole to discover if possible the depth to which the contraction extends. In performing the operation, the patient is so placed that the plantar surface is directed upwards, and an assistant holds the foot and stretches the contracted tissues by making a moderate degree of extension; a sharp-pointed tenotome, with a good stiff blade about an inch or an inch and a quarter in length, according to the extent of contraction present, is selected, and is passed through the skin about an eighth of an inch from, and with the flat side directed towards, the inner edge of the band; the blade is pushed onwards and made to sweep around the whole of the contracted tissues, when the edge is turned, and, the assistant extending the foot as much as possible, the resisting structures are divided with a few even strokes of the blade. The knife is next withdrawn, and the puncture closed with the finger whilst the foot is examined, to discover if any portion of contracted muscle or fascia still remains undivided; such will be the case if the knife has not been carried deeply enough, or sufficiently to the outer side, when making the first incision; then the tenotome must be entered again at the puncture and the necessary division completed. In

cases of long standing, the abductor pollicis muscle and the adjacent fascia generally spring out in prominent relief after section of the central contraction has been made; when they do so, they must be divided either through the first opening, or, which is perhaps better, by making a fresh incision about an inch and a half behind the great toe. Complete section of the contracted muscle and fascia having been obtained, each small wound is closed with a pad of lint fastened by a piece of strapping, and over this a larger pad is placed to produce pressure and prevent subcutaneous hemorrhage from any small vessels that may have been divided, the whole being secured by a bandage; a flexible splint, well padded, is then placed on the leg and foot to keep the latter at rest. After three days all the dressings are removed, and the superficial wounds, which are merely small punctures the size of the blade of the knife, will be found to be completely healed; mechanical treatment is then at once commenced.

The object of *mechanical treatment* is to keep the foot in the improved condition in which it can be placed after the division of those structures in the sole which by their contraction contributed to the deformity, and to overcome other obstacles which still exist to complete restoration of the foot to its normal shape, and which are not amenable to operative interference. In a case of advanced deformity of the nature illustrated in Fig. 716; the fore-

Fig. 719.



Adams's shoe for treatment of
talipes equinus.

part of the foot cannot be put in its proper place after section of the plantar fascia, because the ligaments connecting the under surfaces of the astragalus and os calcis with the scaphoid and cuboid bones have become structurally shortened, a condition which can only be overcome by long-continued mechanical extension. The instrument employed for this purpose is a Scarpa's shoe, which is admirably devised to fulfil the requirements of practice; this shoe, as improved by Mr. Adams,¹ consists of a sole-plate divided at *t*, and supplied with a cog-wheel allowing the forepart of the plate *e* to be raised and lowered in the direction of the dotted line *g*; to the heel-piece are attached three straps, of which the central one passes over the front of the ankle-joint, and then between the side of the heel and the heel-piece, through the slot cut at the back of the latter, to be fastened to a buckle on the outer surface; this strap, which is

called the skate-strap, is of great assistance in fixing the heel firmly in the shoe. On the forepart of the sole-plate there is a strap and toe-wire by which the front of the foot is fastened to the instrument; connected with the heel-piece is the steel bar *b*, bearing the calf-plate *a*, and a cog-wheel, placed at *e*, permits of flexion and extension being made at a point corresponding to the ankle-joint. The foot and leg having been evenly covered with a bandage, the instrument before it is applied is first "set" so as to exactly correspond to the original condition of deformity; the heel-piece is raised to the degree of elevation of the heel present in the affected limb by using the cog-wheel corresponding to the ankle-joint at *e*; and the front of the sole-plate is lowered by the cog-wheel at the division *f*, to an extent equal to the distortion of the foot at the transverse tarsal joint. In applying the instrument, the surgeon, sitting below and in front of his patient, and flexing the knee to about half a right angle, drops the affected limb into the instru-

¹ Op. cit., page 136.

ment; the skate-strap is then fastened with the other straps at the heel; next the calf-plate is fixed; and finally the front of the foot is secured to the sole-plate.

The whole success of the mechanical treatment of the case depends upon the skill with which the instrument is applied and used, and from a want of appreciation of this fact an imperfect result very frequently follows; it is quite remarkable how one can blunder in his first attempt to apply a Scarpa's shoe, the trouble usually arising from not properly adjusting the shoe according to the condition of deformity, and from fastening first the wrong parts of the instrument. If the former of these errors is committed, the heel of the foot does not properly fall into the heel-piece of the shoe; having overcome this fault, the course above described of commencing by fastening the heel, then the calf-plate, and finally fixing the forepart of the foot, should always be followed; by so doing the part of the appliance which is kept immovable during this stage of treatment is first made firm, and then the acting portion of the appliance is put ready for use. For the first twenty-four hours, the limb is merely kept resting in its original state of deformity; the instrument is then taken off, and the foot and leg are examined to see if too much pressure has been exercised at any one spot from over-tightening of the straps; a fresh bandage is applied, and the instrument replaced, the front of the foot being raised upwards as much as can be comfortably borne by the patient. The elevation of the displaced structures is daily carried on by the mechanical extension thus exercised; no attempt must be made to force the foot into shape by bringing into play the full power of the instrument; if such a strain is put upon the foot as to give rise to swelling or pain, the pressure must be immediately relaxed, as otherwise the skin will be excoriated by the tightened straps, and the only remedy will be to give up treatment until the abraded surface is again sound. It may be accepted as a golden rule in the mechanical treatment of this and all other varieties of deformity, that the instrument in use should be applied firmly but should never be tightly fastened. The reduction of the deformity of the foot in a case such as is now being considered, will take from two to three months to complete, and when the contraction of the plantar surface has been overcome, the restoration of free movement at the ankle-joint must be proceeded with.

At this stage of treatment is presented the first difficulty in deciding upon what measures are the best to adopt; as to the necessity for operative treatment in the first stage, no room for doubt exists, but whether or not it is desirable to resort to tenotomy for the restoration of free movement at the ankle, is a more open question. The obstruction here depends upon shortening of the gastrocnemius and soleus muscles, with contraction of the Achilles tendon, and also upon stiffening of the joint from want of use. The first of these causes arises from acquired, as distinct from active contraction; that is to say, the muscles and tendon have become shortened, not from any change in their normal properties, but from being placed in a condition which has prohibited their healthy action. Upon this arises the difficulty of selecting what course of treatment to pursue, whether to relieve the contraction by section of the Achilles tendon, or whether to rely upon a constant application of mechanical extension, combined with physiological measures, to overcome the shortening of the muscles. The limb must be examined to ascertain to what extent the contraction of the Achilles tendon prevents the movement of flexion in the joint; if the case is one of long standing, and the foot cannot be brought to a right angle with the leg when the limb is straight, and the patient is also unable when standing up to flex the leg further on the foot without raising the heel, it is necessary to resort to

tenotomy; if, on the other hand, flexion beyond the right angle can be obtained to such an extent that the patient, with the foot placed on the ground, can bend the knee so far forwards as to bring it in a line with the great toe, tenotomy is not required; it is the condition of contraction between these two degrees which renders the question of resorting to section of the tendon one requiring some care to decide upon.

Section of Tendo Achillis.—The division of this tendon in a healthy leg, or when practising on the dead subject, is a very simple operation; but in the case of paralytic equinus, it is by no means so easy to divide the tendon deftly; in the paralyzed limb all the tissues are much wasted, there is consequently very little subcutaneous fat, and the skin folds closely over the tendon, bringing it into strong relief. This is so far an advantage that the size of the tendon can be readily computed, but it renders the performance of subcutaneous division much more difficult than it would be if the superficial tissues were less closely adjacent to the structure which has to be divided. The dangers which have to be avoided are, making a second puncture of the skin on the opposite side of the leg to that on which the tenotome is entered, increasing the size of the first puncture during the section of the tendon so as to produce a gaping wound, and lastly cutting through the skin over the tendon after division of the latter has been completed. All these accidents have frequently happened in practice: the first is of no great importance, but the two latter may lead to serious complications; they usually arise from too great haste on the part of the operator to complete the section of the tendon, although the misfortune of cutting through the skin over the tendon may be chiefly due to want of caution on the part of the assistant who holds the limb. In performing the operation, the patient is placed in the prone position, and an assistant, standing on the left side of the operator, tightens the tendon by holding the leg firmly with his left hand and with his right grasping and flexing the foot; the calf of the leg must not be gripped tightly so as to interfere with the circulation, nor must the foot be too forcibly flexed. The operator enters the tenotome, holding it as he would a pen, at the thinnest portion of the tendon, about a line from its edge, and, in the position in which the patient is placed, near its upper surface,¹ the flat side of the blade being towards the tendon; the knife is pushed obliquely downwards, and passed behind the tendon until the edge of the latter opposite to the side of puncture is reached; the handle is then depressed until the knife is horizontal, when the cutting edge is turned and the tendon divided by even strokes of the blade; as the last few fibres are divided, the knife must be kept under command, since otherwise, especially if the foot is forcibly flexed, the blade will be jerked against the skin and an open wound made over the tendon. The object of entering the knife well above the lower surface of the tendon, and passing it obliquely downwards, is to avoid enlarging the puncture during the performance of the operation; if entered too low down, the handle has to be depressed, and the tendon is scratched through with the point of the knife instead of with a few free sweeps of the blade. The complete division of the tendon is followed by separation of the divided ends, the amount of space which intervenes depending upon the contractile power of the gastrocnemius and soleus muscles. If these are much wasted, the space will be very small; but if they are in a fairly healthy condition, the separation will be to about the extent of one inch.

If the tendon has not been perfectly severed, the knife has probably pierced its deeper fibres instead of passing underneath it, or else it has not been carried

¹ Anatomically its posterior surface; but to avoid confusion in this description, anatomy is disregarded, and the position of the patient rules the terms as to direction.

far enough to the side opposite to that of puncture, and some fibres at the edge of the tendon have been left undivided; in such cases the knife must be entered again and the section made complete, and the same must be done if the small plantaris tendon has not been severed. The operation should be a bloodless one, a result which is to be obtained by keeping the knife as close as possible to the side and under surface of the tendon. There is some slight risk of wounding the posterior tibial artery if the knife be entered on the tibial side of the leg, and pushed too far down before turning it; but this may be avoided by entering on the fibular side, and this is the safest course to pursue with infants or very young children; in older subjects, either side of the leg may be entered if the knife be kept within proper limits. After the operation, the small wound is closed with a pad of lint and strapping, another pad of lint is placed over this, and the limb is secured to a flexible splint with the foot in the extended position. At the end of four days the dressings may be removed and the use of the Scarpa's shoe be resumed; by using the cog-wheel at *c*, flexion of the foot and lengthening of the tendon must be gradually obtained, treatment being carried on very slowly; for if too much haste is made in these cases of paralytic equinus, the union will be weak and the new tissue will always be liable to stretch and leave the patient with the opposite condition of deformity, calcaneus. It is never desirable to restore full flexion at the ankle, but to stop when about half the normal degree of movement has been gained, this being quite sufficient for all the ordinary purposes of walking, running, etc.

Treatment by Manipulation.—The treatment of paralytic equinus in which the Achilles tendon only so far limits movement by its contraction as to prevent the foot from being flexed beyond the right angle, is generally better conducted by mechanical and physiological measures than by tenotomy; such a course of treatment should always be first adopted with young children, or in cases in which there is much wasting of the limb, it being understood, of course, that there are present no other reasons, such as will hereafter be described, for resorting to tenotomy. The mechanical treatment consists in the use of a Scarpa's shoe in the same manner as when the tendon has been divided, only that the extension may be pushed on as quickly as can possibly be done without causing injury from the exercise of too much force. The physiological measures employed are daily flexion of the foot on the leg, which may be accomplished either by manipulation or by means of an instrument; if done by hand, an attendant holds the leg firmly, keeping the knee extended, and with the other hand flexes the foot as far as possible; he then relaxes and again flexes the foot, continuing the exercise for as long a period as may be thought advisable. The patient may himself conduct the same exercise by using an instrument constructed on the plan of Stromeyer's exercising board; this consists of a frame to which is fixed a trough for the leg; to the leg-piece is attached, by a free joint corresponding to the ankle, a contrivance to hold the foot, which is constructed very much like the foot-portion of an ordinary Scarpa's shoe; to the end of this is jointed a steel rod about two feet long and supplied with a handle; the leg and foot being fastened to this appliance, the patient by means of the rod works the foot-piece backwards and forwards, and so extends and flexes the foot on the leg. A still better method is for the patient to place the toe of the affected foot against the wall of a room, and, whilst keeping the foot flat on the floor, to endeavor to flex the ankle-joint as much as possible; then relax and again flex, taking care when so doing not to raise the heel from the ground. After employing this exercise for some days, the knee will probably be made to touch the wall; the foot must then be drawn back, and the distance be gradually increased until free movement has been

established. The advantage of this method is that it is more interesting to the patient, as he is able to watch exactly the amount of progress made, whereas the mechanical exercise is rather monotonous, and on that account is often neglected. If, after a fair trial of one or all of these methods, the contraction of the tendon does not yield, tenotomy must be resorted to.

A case presenting well-marked characteristics of paralytic equinus, such as that above considered, serves as a standard as regards treatment with which to compare the modifications required in the management of other conditions of the deformity. In the table before given, three states of paralytic equinus are classified, each state being again separated into two groups according to the time that the deformity has existed. In the early stage of equinus, resulting from slight loss of power of the flexor muscles of the foot, the distortion is readily overcome by the use of the physiological method of treatment alone; if, however, this condition has existed for three or four years, it may be accompanied by some contraction of the plantar fascia with deepening of the sole of the foot. When this latter condition has been developed, division of the contracted band of fascia is the right course to adopt; there is nothing to be gained here by resorting to mechanical means, which may be successful, but which will take a much longer time to gain the desired result, while the division of the fascia cannot possibly be productive of ultimate harm. Should the Achilles tendon be contracted, even to such an extent that the foot cannot be flexed to a right angle with the leg, mechanical and physiological measures must first be employed; the desirability of not lengthening the tendon if it can be avoided is obvious, and moreover the risk of developing calcaneus is always present in these cases. Having reduced any distortion of the foot itself that may have existed, the use of the Scarpa's shoe is continued to overcome the shortening of the contracted muscles; if interference with flexion of the foot is only slight in degree, the constant use of the shoe is not necessary, but the child may be allowed to walk with a steel support attached to the foot, and with a flexion-spring to assist the weak anterior muscles and counteract the action of the extensors, the shoe being worn at night, and as many hours during the day as may be thought desirable. Exercise of the foot by one of the methods previously described, and the employment of galvanism and of shampooing to stimulate the paralyzed muscles, are also necessary parts of the treatment. When the loss of muscular power is more severe, the deformity in the early stage usually yields to the measures just described as suitable for the second stage of slighter paralysis; but if of some years' standing, and if the heel is drawn up, section of the Achilles tendon is required, always remembering that any shortening of the sole of the foot that has been caused must first be relieved. In the condition of complete loss of power of the anterior muscles, the early stage may be submitted to treatment without operation, but in the later stage operative measures must always be employed. Spasmodic equinus is treated on the same lines as those drawn up for the relief of paralytic deformity, but section of the tendo Achillis is always to be avoided if possible, and in no case should tenotomy be performed so long as the exciting cause of muscular contraction is at work.

Talipes Arcuatus.—In describing the characteristics of talipes equinus, frequent mention has been made of the existence of two conditions which contribute to the deformity—shortening of the foot with contraction of the plantar tissues, and extension of the foot on the leg from contraction of the posterior muscles. Both these conditions are dependent upon paralysis of the flexor muscles, the first arising from the front part of the foot falling down and becoming displaced from the astragalus and os calcis at the trans-

verse tarsal joint, the other from elevation of the heel by the unbalanced action of the extensor muscles. The degree of each condition present varies considerably in different cases of the deformity: in one foot, the contraction in the sole is the chief feature; in another, the elevation of the heel is the most prominent symptom; it has therefore been proposed to distinguish between the two forms of *talipes equinus* by limiting the term *equinus* to the latter state of distortion, and to apply to the former the title of *talipes plantaris*.¹ I have not adopted this method of nomenclature, because the two conditions are nearly always associated together, although one may be greatly in excess of the other, so that, to be strictly accurate, the term *equino-plantaris* would have to be used in the majority of cases; this would fail to convey any clear definition of the exact nature of the deformity, or to point out which was the chief characteristic of any particular case. There is, however, a state of distortion of the foot which consists of contraction of the sole without any depression of the forepart of the foot, and with no interference with the position of the foot on the leg; it distinctly differs from *talipes equinus* in that the heel and toes are on the same level, and the only defect is increased deepening of the arch. This deformity is by no means an uncommon one, and from the fact that in its early stage it rarely attracts notice, unless the heightened arch is welcomed as a point of beauty, it is often allowed to advance until the subject becomes seriously crippled. As this condition cannot be classified with any of the other recognized varieties of club-foot, I have employed the term *talipes arcuatus* to distinguish the deformity, and to indicate the nature of the distortion.

An extreme instance of *talipes arcuatus*, occurring in a boy nine years old, is illustrated in Fig. 720; the foot was $7\frac{1}{2}$ inches long, and so much contracted in the sole that the centre of the arch was $1\frac{1}{2}$ inches above the level of the heel and toes, whilst the middle of the outer border of the foot was raised $\frac{3}{4}$ of an inch; the instep was also very high; the movements of flexion and extension at the ankle-joint were quite normal.

Although *talipes arcuatus* seldom presents such a marked degree of distortion as is shown in this case, it is nevertheless an unmistakable condition of deformity; when brought under the notice of the surgeon, relief is generally sought from the discomfort produced by a row of corns along the front part of the foot, and from the occurrence of pain at the transverse tarsal joint; an examination of the foot reveals that the arch is abnormally long and high, so that the treading surface is much reduced in space. The deficiency in this latter respect is shown in the accompanying figures (Figs. 721 and 722) of two feet of the same patient, the right foot being affected with *talipes arcuatus*, and the left being normal; the loss of surface in the right foot is at the front of the heel, at the centre and inner border of the middle of the sole, and at the forepart of the foot, which is wider from side to side, but narrower from before backwards; the foot is also considerably shortened. The source of the deformity is not easy to discover, because the cases are seldom seen until the contraction has been present for some years. It is more frequently met with amongst the better class of people, and not

Fig. 720.



Talipes arcuatus.

¹ The name *talipes cavus* has also been used to distinguish this condition of deformity; but the word *cavus* is by no means a good one, as it signifies hollow like a tube.

uncommonly the subject has been attacked with scarlet fever at about the time at which the contraction may be supposed to have commenced ; beyond these clinical facts there is nothing that I have observed which can clear up the question of etiology. Possibly the fact that the feet of children amongst the prosperous are more tightly constricted than amongst the poor, may

Fig. 721.

Diagram of foot in talipes arcuatus ($\frac{1}{4}$ natural size).

Fig. 722.

Diagram of normal foot ($\frac{1}{4}$ natural size).

contribute to the greater liability of the former to the affection. Muscular disturbance is a not unfrequent sequel of scarlet fever and other acute diseases in childhood, and contraction of the plantar muscles, so induced, may be the original cause of distortion of the foot ; but with our present limited knowledge, these are at the best only speculative suggestions upon an obscure subject.

The *treatment* of talipes arcuatus is not attended with any difficulty, and the measures adopted are very similar to those already described as required for the relief of plantar contraction in talipes equinus. Section of the plantar fascia and of the superficial muscles of the sole of the foot, is necessary when the deformity has existed for a lengthened period of time ; in the mechanical treatment, after operation, an apparatus somewhat similar to the foot-piece of a Scarpa's shoe is used, but a strap passing directly over the instep to each side of the sole-plate is required, to give resistance to the mechanical pressure brought to bear upon the heel and forepart of the foot ; the reduction of the deformity should be carried on as quickly as is consistent with the careful application of the mechanical power of the instrument. The result of treatment is always satisfactory, for although complete removal of the contraction of the arch is not invariably obtained, the treading surface of the foot can be sufficiently enlarged to enable the patient to walk with perfect comfort. The case illustrated in Fig. 720 was under treatment for two months, and at the end of that period the outer margin of the foot was brought level with the heel and toes, and the plantar surface was greatly increased ; in the other case of which diagrams are given, that of an adult, there was no difference in the length of the two feet after three months' use of the shoe ; in both cases the contracted tissues in the sole of the foot were divided.

TALIPES VARUS.—Talipes varus, like the other varieties of club-foot, occurs both as a congenital and as a non-congenital affection ; the congenital form is by far the most common, and possesses especial interest for the twofold reason that it is the most severe in its nature, and the most difficult to cure, of all the distortions of the foot.

Congenital Varus.—This presents many degrees of distortion, but the characteristic features of the deformity are that the foot is adducted, inverted, and extended: the adduction and inversion consist chiefly of displacement of the forepart of the foot from the astragalus and os calcis; the extension is mainly due to altered relationship of the foot with the leg. The forepart of the foot is so changed in position that the sole is turned backwards, and the dorsum forwards, and that the toes point directly inwards; the inner border is twisted upwards, and forms about a right angle with the inner surface of the leg; the outer border is directed downwards. The heel is raised, and is unnaturally small in size; the outer malleolus is unusually prominent, whilst the inner malleolus is partially hidden by the inverted foot, and is also often ill-developed. The integument of the foot is implicated in the deformity; on the inner border it is tense and shiny in appearance, bearing some resemblance to cicatricial tissue, and there is frequently a deep sulcus which runs into the sole of the foot and corresponds to the position of the transverse tarsal joint; along the outer border, and on the dorsum, the skin is loose and apparently over-abundant, whilst at the heel, usually on the inner side and just above the insertion of the tendo Achillis, there occurs a second sulcus with contraction of the superficial tissues.

From the above description it will be seen that congenital varus consists really of the combined forms of varus and equinus; the extent to which these conditions of deformity may exist is, however, very variable, as may be observed from an examination of the following figures, taken from casts of the distortion. Fig. 723 illustrates a condition of slight varus with an

Fig. 723.

Fig. 724.

Fig. 725.



Congenital talipes varus with extreme equinus.

Congenital talipes varus with extreme varus.

Congenital talipes varus with severe equinus and varus.

extreme degree of equinus, the deformity here consisting chiefly of extension of the foot on the leg; Fig. 724 shows a marked state of varus with but little elevation of the heel, the principal distortion being at the transverse tarsal joint; Fig. 725 represents a severe degree of both varus and equinus.

Anatomical Changes in Congenital Varus.—The changes in the anatomical structure of the foot which occur in congenital varus, consist in an alteration in position and shape of some of the bones, together with an abnormal con-

dition of the ligaments. Of the *bones*, the os calcis is affected chiefly as regards its position, which is so changed that the long axis of the bone, instead of being horizontal, is directed vertically, the posterior surface pointing upwards and a little outwards, whilst the anterior surface is turned downwards and slightly inwards; in shape the bone is not altered. The astragalus is thrown forwards and downwards, so that its superior articular surface, which is normally in direct relationship with the under surface of the tibia, appears on the dorsum of the foot, while the anterior articulating surface, which enters into the formation of the astragalo-scaphoid joint, is directed downwards and inwards; the inward direction of the head of the bone is contributed to by the neck being slightly twisted that way, an interesting change in the shape of this bone which was first described by Adams.¹ The scaphoid bone is greatly displaced: not only does it follow in direction the head of the astragalus, but it is still further pulled away from the articular surface thereon, in a direction upwards, inwards, and backwards, so as to be brought into apposition with the internal malleolus; the anterior surface of the scaphoid thus points inwards instead of forwards, and its posterior surface outwards instead of backwards; the tubercle on its inner surface is also directed upwards, and its outer surface is turned downwards. The other bones of the foot—the cuboid, cuneiform, and metatarsal bones—merely adapt themselves in position to the changed situation of the os calcis and scaphoid.

The *ligaments* are naturally affected by the marked change in the shape of the foot; their points of attachment are, according to their position, either more closely brought together or unduly separated; the former is the case with the deltoid or internal lateral ligament, the plantar fascia, and the calcaneo-cuboid and calcaneo-scaphoid ligaments of the sole; as a consequence, these ligaments are all shortened and contracted, while the astragalo-scaphoid ligaments and the anterior ligament of the ankle-joint are stretched and weakened.

The *muscles of the leg and foot* are generally well developed in cases of congenital talipes varus, but those which by their action extend and adduct the foot upon the leg are structurally shortened and contracted. The gastrocnemius and soleus muscles are in this respect affected to a degree which corresponds to the amount of equinus existing in the particular case of deformity; when the heel is much raised, the tendo Achillis is firmly contracted and somewhat displaced to the outer side of the leg. The fibialis posticus and anticus muscles are shortened to an extent depending upon the amount of inversion and adduction of the foot which is present; the former is usually very tense, and its tendon is considerably displaced, for, owing to the changed position of the scaphoid bone, it passes directly downwards to its point of insertion; the tibialis anticus is also affected in the same manner from the altered situation of the cuneiform bones, and its tendon is deflected considerably to the inner side of the leg and foot. The other muscles of the leg present no peculiarities deserving especial notice except in cases of severe deformity, when the extensor proprius pollicis is somewhat contracted, while the extensor longus digitorum and peronei muscles are small and ill-developed.

Etiology of Congenital Varus.—Much difference of opinion has existed amongst authorities as to the etiology of congenital varus: the principal theories of causation that have been advanced are, the influence of maternal impression, the pressure of the uterus, arrest of development, and the existence of nervous disturbance. The influence which *maternal impression* may

¹ Op. cit., page 152.

have upon the fœtus has often been discussed, but, although cases have been quoted in support of the sympathetic development of certain abnormalities, little more has been proved than can be explained by the laws of coincidence. Even supposing that in a certain number of cases the evidence of mental disturbance is to be traced, nevertheless, in the large majority of instances, no such history is given; again, the mother's account must always be received with some suspicion, for, regarding the club-footed infant as a reflection upon her constructive abilities, she eagerly catches at the somewhat poetical idea of having received a shock during pregnancy upon seeing some unfortunate cripple, and thus satisfactorily relieves herself of all responsibility in the matter.

In support of the theory that congenital varus results from *pressure of the uterus*, it has been argued that the natural position of the feet of a fœtus corresponds to the abnormal condition of deformity; and that if from deficiency in amount of the liquor amnii, or other cause, the fœtus is unduly pressed upon, congenital varus is established. If this explanation were correct, the lower extremities would also participate in the deformity, and would retain the flexed position which they had assumed *in utero*; moreover, the greater the distortion of the foot the more severe would have been the pressure of the uterus, and even supposing that the fœtus was able to live under such a condition, there would of necessity be developed a corresponding state of deformity in other parts of the body. That *arrest of development* has any productive effect in the origin of varus, is disproved by the fact that the feet are usually abnormal only in shape, and that, except in severe cases, there is no defect in tissue-formation of the bones, muscles, or ligaments. Deformity of the foot is occasionally the result of arrest of development, but such cases are comparatively rare, and when so produced the distortion is always accompanied by very distinct evidence of defective construction, such as the absence of one or more toes, smallness of the limb, and similar conditions.

It is in the existence of *disordered nervous influence*, and consequent muscular disturbance, that we must seek for the cause of congenital club-foot. And here the question arises, From what form of nerve lesion does the deformity originate? Is it from loss of nerve-function with paralysis of the muscles, or from nerve-irritation with spastic muscular contraction? Undoubtedly the weight of evidence is strongly in favor of the latter theory. In support of the theory that paralysis of the muscles which flex and abduct the foot—the extensors of the toes and the peronei—first occurs, and that the extensors and abductors overpower their weakened opponents and so cause the deformity, it has been urged that the distortion can easily be reduced soon after birth by drawing the foot into its normal position, and by thus giving assistance to the feeble muscles. In slight cases of deformity the foot can be thus readily placed in position, and in such cases the child when stretching out the legs exerts sufficient muscular power to overcome the distortion; but if the muscles were paralyzed, it would, from the very nature of their condition, be impossible for them under any circumstances to overcome their more powerful opponents, whilst if the ease with which the deformity could be overcome were to be taken as a sign of paralysis existing, then no matter to what degree distortion had been developed, reduction should be effected with equal facility in all cases, because in all the resisting force would be the same. The theory that spasmodic contraction of the gastrocnemius, soleus, tibialis posticus and anticus muscles, is the cause of congenital club-foot, is supported by the fact that these muscles are always more or less firmly contracted, and that the degree of resistance to reduction of the deformity is directly proportionate to the amount of muscular shortening which is present; moreover, the displacement of the bones exactly corresponds to the effect which would be

produced upon the foot by abnormal contraction of these several muscles; further, of the non-congenital varieties of talipes varus, that arising from spasmodic muscular contraction bears a much greater resemblance to the congenital form than does that resulting from paralysis; and again, paralytic equinus is the most frequent of the acquired forms of club-foot, and the most uncommon of all congenital deformities. In describing the causation of non-congenital club-foot, it was noticed that the earliest cause acting after birth was irritation of the nerve-centres; and it is not unreasonable to suppose that the fœtus is especially liable to the same nerve-excitation, and that during the period of development *in utero* the nervous tissue is particularly sensitive to morbid influences. If this deduction is correct, we should expect to find spastic muscular contraction and deformity complicating cases in which there is defect of development involving the nervous system; and such is in fact the case, for in the anencephalic fœtus, and in those affected with spina bifida and other malformations implicating the nerve-centres, there is often present the condition of club-foot. The case of varus illustrated in Figure 725 occurred in a child who was also affected with congenital deformity of the spine. The column presented somewhat the same condition that arises from extensive caries of three or four of the bodies of the vertebræ, with greater destruction on one side than on the other, and with the formation of severe angular deformity combined with lateral displacement; both feet were distorted to an extreme degree, and the muscles were very rigid. No doubt there had been, in this case, arrest of development of the bodies of the vertebræ, and local irritation of the spinal cord had been present; for some few weeks after birth the child was subject to clonic spasms of the muscles of the lower extremity, which prevented any treatment being undertaken for the relief of the deformity of the feet. The child is still under observation, being now seven years old; the varus is quite cured, but from the deformity of the spine she is not taller than a well-made child of two years.

Treatment of Congenital Talipes Varus.—The treatment of congenital varus is divided into two stages: first the foot itself is restored to its natural form, and afterwards the elevation of the heel is overcome and the normal position of the foot with the leg is obtained; the reasons for following this course are similar to those already explained in describing the treatment of talipes equinus; the inversion and adduction of the foot depend upon displacement of the bones at the transverse tarsal joint, and hence this defect is more easily removed by retaining the immobility of the os calcis and astragalus, whilst proceeding to place the anterior portion of the foot in position. The muscles which have by their contraction induced, and which by their shortened condition maintain, the inversion and adduction of the foot, are the tibialis posticus and tibialis anticus; and in commencing treatment, the first point to be decided is whether or not section of the tendons of these muscles is necessary. In cases in which the distortion of the foot exists only to a slight degree, such as that illustrated in Fig. 723, tenotomy is not required; but when the deformity is more severe, and the foot firmly resists all attempts to restore it to its proper position, section of the tendons must be performed.

Subcutaneous division of the *tendon of the tibialis posticus muscle* presents some difficulties, because it is deeply situated, and, especially in a fat child, is not readily detected. The patient is so placed that the inner surface of the leg looks directly upwards, and that the anterior surface is turned away from the operator. An assistant steadies the limb by holding the foot and leg, and a sharp-pointed tenotome is entered about three-quarters of an inch above the ankle, exactly in the centre of the inner surface of the leg; it is pushed on until the edge of the tibia is reached, the sheath of the tendon being freely opened by a few strokes of the blade. The sharp-pointed knife

is then withdrawn, and one with a blunt point is entered through the puncture, slipped through the opening made in the sheath, and passed between the tendon and the bone; the flat side of the blade has been so far kept towards the tendon, but the cutting edge is now turned, and, the assistant abducting and flexing the foot to render the tendon tense, a few strokes of the knife readily effect its division.

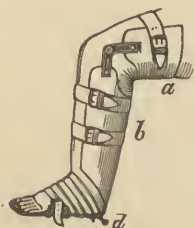
The *tibialis anticus tendon* is next divided, the point selected being just in front of the ankle-joint; and in seeking for this tendon it must be remembered that it is displaced to the inner side of the leg. The child is turned slightly over on his back; a small, sharp-pointed tenotome is entered on the outer side, so as to avoid the *dorsalis pedis* artery, and passed beneath the tendon; this is always considerably contracted, and, on turning the cutting edge of the knife, is usually divided by simple pressure; the assistant should slightly extend the foot, but should not exercise any force, as from the length of this tendon the divided ends separate very much after the section is completed. The small wounds made during the operations are closed with pads of lint directly after the knife has been withdrawn; the leg is then carefully bandaged; and a flexible splint, bent to a degree corresponding to the original condition of deformity, is fixed to the leg and foot.

The division of the *tibialis anticus tendon* is an operation which presents no difficulty; the only practical points deserving notice are, first, that the knife must be entered on the outer side of the tendon, as otherwise the *dorsalis pedis* artery is almost sure to be cut, and secondly, that the assistant must not make too forcible extension of the foot, for this little tendon flies asunder so readily that the knife is liable to be jerked through the skin, making an open wound. The section of the *tibialis posticus tendon* is not so simple a matter, on account of the depth at which it is situated, and of the close proximity of the posterior tibial artery. It is probable that this vessel is not unfrequently wounded by those not well practised in the method of dividing the tendon: no harm is likely to result if the artery is cut completely through when severing the tendon with a blunt-pointed knife; but if it be pricked with the sharp-pointed tenotome, a traumatic aneurism will probably be formed. I believe that I have divided this artery on two occasions; at any rate, on withdrawing the knife a spurt of arterial blood issued through the puncture in both cases; pressure was applied, and maintained by pads of lint for six days, and no harm followed upon the accident. In these operations the blunt-pointed tenotome was used; both of the children were puny little infants with very small legs. In robust, well-developed children, the use of the blunt-pointed knife is not so necessary, because the distance between the artery and tendon is greater; it is however safer to use the blunt tenotome if the operator is not often in the habit of performing the operation. The section of the tendon is not plainly recognized when completed, as in the case of the *tibialis anticus tendon*, and this difference is due to the fibres of the posterior muscle being prolonged down to the point at which the section of the tendon is made; for this reason, care must be taken to effect the division as low down the leg, and as near the ankle, as can be done without risk of injuring the posterior tibial artery. The inner border of the tibia is the guide by which the tendon is found; the sharp-pointed tenotome will strike this part of the bone if it be entered exactly in the middle line of the leg; if the proper spot be missed, a little careful manipulation, using the point of the knife as a probe, will find the edge of the bone; the sheath of the tendon is then opened, and when the blunt-pointed knife is passed through this and between the tendon and the bone, it will be held firmly between those structures, and the operator may feel assured that the blade is in the right position for completing the section.

The reduction of the inversion of the foot, in a case of moderate severity, usually takes about three weeks to accomplish. The method of treatment employed is very simple; a flexible metal splint, well padded on one side and sufficiently long to reach from the knee to half an inch below the toes, with some soft narrow bandages, are all the mechanical appliances required. After the operation the foot is kept at rest, and in the state of deformity which was present before the tibial tendons were divided, for five days, at the end of which time the small punctures are quite healed; the leg is then covered with a bandage from the toes to the knee, and the splint, bent at a point corresponding to the ankle-joint, is placed on the outer side of the leg, and fixed by rolling the bandage around it and the limb, from the calf to the end of the toes. By gradually straightening the splint from day to day, the foot is brought out until it is in a line with the leg, and as soon as it will remain in this position without support, the case is converted into one of equinus, and the second stage of treatment may be entered upon. In cases of severe distortion, four or five weeks are required to overcome the inversion of the foot, and in no case should the treatment of the equinus be commenced until the distortion of the foot is completely relieved. Some surgeons, in slight cases of congenital varus, divide the Achilles tendon at the same time as the tibial tendons, but beyond saving a little time in the treatment of the case, no advantage is gained by this method of procedure; on the other hand, there is always the possibility of the distortion of the foot itself not yielding as readily to treatment as was at first anticipated, and should such happen in a case in which simultaneous section of the three tendons has been performed, the difficulties of treatment will be much increased; it is in my opinion much safer to divide the operation into two stages, in all cases of congenital varus which are sufficiently severe to require tenotomy at all.

The *second stage* of the operative treatment adopted in congenital varus is the same as that already described for the treatment of talipes equinus, but the mechanical measures employed are not quite the same, for it is not only necessary to overcome the extension of the foot on the leg, but care must also be taken to maintain the foot in its improved shape, and to prevent it from becoming again inverted. For the instrumental treatment of varus in this stage, many different sorts of appliance have been invented and used with success; the particular form of instrument is of no great consequence, provided that it is so designed as to enable the foot to be gradually flexed on the leg, and at the same time to prevent its relapsing to the condition of inversion. The splint which best fulfils these requisites is one introduced by Mr. Adams, and illustrated in Fig. 726; it consists of thigh and leg trough-

Fig. 726.



Adams's varus splint.

pieces, *a* and *b*, connected by a free joint at a point corresponding to the knee; to the leg-piece is attached a plate for the foot, with a cog-wheel at *d*, which supplies the movements of flexion and extension; a toe-wire with a strap is fixed to the front part of the foot-plate on its outer side. The method of applying this apparatus will be best understood by studying the drawing; the same manner is followed of first fastening the heel, and then the thigh and leg, before placing the front of the foot in position, as has already been described when treating of the mode of applying Scarpa's shoe in the treatment of talipes equinus; with congenital varus, the further precaution has to be observed of keeping the sole of the foot well extended, and the

inner border quite straight, by drawing the toes over to the outer side of the instrument, with the strap and toe-wire.

The most favorable time for commencing treatment is when the infant is about six weeks old, but much depends upon the condition of the patient: in a robust, healthy child, an earlier commencement may be made, while in a weak infant treatment should be delayed; from two weeks to three months may be estimated as the limit of age in the respective conditions. After the deformed foot has been restored, the use of the instrument must be continued until the child is able to walk, when a light steel support, fixed to the boot, will be required; in slight cases, a bar extending to the calf on the inner side of the leg, with a free joint at the ankle, and a strap attached to the boot so as to brace up the foot against the support, is sufficient to keep the foot in good position when walking; in cases of more severe deformity, the instrument must be extended to the thigh, or if necessary to the waist, to overcome any tendency to adduction of the limb which may be present. The shoe must be worn at night, and instrumental treatment continued, until the foot is perfectly restored to the normal state; although a difference of opinion still exists as to whether spasmodic contraction of one set of muscles, or paralysis of their opponents, is the exciting cause of congenital varus, few surgeons will dispute the fact that an abnormal condition of the muscles is the source of deformity, and the supporters of either of the two theories must be in accord upon one point, viz., that until the muscles are restored to a normal condition the exciting cause of distortion still exists, and will to a certainty, if not counteracted, reproduce the displacement of the foot. It must therefore be accepted as an established rule, that the treatment of congenital varus is not successfully concluded until the subject is able to walk with the foot everted, and with the plantar surface placed well on the ground.

Congenital Varus in Advanced Life.—Congenital varus, when not relieved in infancy, becomes with advancing age greatly increased in degree; and this is probably due, not as much to shortening of the contracted muscles, as to the mechanical effects of pressure brought to bear upon the foot when used in standing and walking. The structural defects in a case of advanced varus are of the same nature as those already described as existing in the infant, but they become aggravated by time, and are more firmly established; the growth of the foot is checked, and the tarsal bones are badly developed, their articular surfaces being also very irregular in shape and position. The os calcis, in addition to an increase in the vertical direction which it assumes in the infant, becomes changed in shape from arrested growth of the greater tuberosity; the displacement of the astragalus from the tibia is more marked, and the head and neck of this bone are small in size, whilst the latter is still further deflected inwards; the articular surface on the outer side of this bone is separated from the external malleolus, and that on the inner side is imperfectly developed. The scaphoid bone is the most seriously displaced of all the tarsal bones, its position being the same as in the case of infantile deformity, but its abnormalities in this respect being much exaggerated; the cuboid bone is dragged inwards and partially dislocated from the os calcis; the cuneiform bones retain their places on the scaphoid; and the metatarsal bones, which follow them and the cuboid, are much pressed together. The ligaments are seriously implicated in the deformity; the plantar fascia and calcaneo-cuboid and calcaneo-

Fig. 727.



Advanced congenital varus.

scaphoid ligaments, which are shortened at birth, become so firmly contracted that they offer the chief obstacle to reduction of the deformity.

The external appearances presented by a case of advanced varus correspond to the changes which occur in the structural shape of the foot; Fig. 727 illustrates the foot of a boy aged six years, in whom congenital varus had been allowed to continue its course without the employment of any form of treatment for its relief. The parents of this boy were shown casts of the varying conditions of varus in its early stage, and selected one of quite a moderate degree of severity as showing a deformity similar to that which had existed in their son's foot at birth; in a comparatively short time, the distortion had reached the extreme condition illustrated in the drawing, which clearly indicates the great importance of overcoming congenital varus at as early a period of life as possible.

The features exhibited in this case were quite characteristic of those usually presented in advanced varus: the heel is much raised, and the tendo Achillis is in prominent relief and firmly contracted; below the heel, on the part of the foot which has been used in walking, is a large pad of thickened skin and cellular tissue, which supplies the place of the normal heel; this pad, when the deformity of the foot has been reduced by treatment, becomes situated on the upper surface of the dorsum, at about the seat of the cuboid bone. Running across the sole of the foot from its inner border, is a depression which corresponds to the transverse tarsal joint, and which arises from shortening of the foot and contraction of the plantar fascia; another groove, which passes forwards from this to the great and second toes, is caused by the folding together of the metatarsal bones; and the front portion of the foot, from the same cause, presents a peculiar, twisted appearance. The condition here represented is by no means the ultimate state of deformity; as age increases, the distortion advances, but the characteristics are of the same nature and differ from those above noticed only in degree. A further complication exists in these cases from the extreme wasting of the muscles; this is owing to their want of use, for, since the foot is almost immovable on the leg, these muscles are never called into action.

The *treatment* of varus existing at a later period of life is carried on in the same manner that is followed in infantile cases; but it is necessary in this more severe condition of the deformity to divide the course of treatment into three stages; in the *first stage* the foot is brought in a straight line with the leg, in the second the contraction in the sole of the foot is overcome, in the third the elevation of the heel is reduced. It is of course always necessary to have recourse to tenotomy, and, as in the case of infantile varus, the tendons of the tibialis posticus and tibialis anticus muscles are first divided. The mechanical after-treatment is conducted on a similar plan to that already described, and by means of an outside splint attached to the leg the inversion of the foot is gradually reduced; this part of the treatment cannot however be always successfully accomplished by mechanical extension alone, and when after six or seven weeks' employment of the splint it is found that the foot still firmly resists the constant pressure that has been brought to bear upon it, it is necessary to have recourse to manipulative exercises, or, as it is technically called, *hand-working*, to overcome the condition of inversion. The resisting structures which have to be dealt with are the shortened and contracted ligaments which connect the os calcis and astragalus with the scaphoid and cuboid bones; these, from their situation, are of course not amenable to operative measures.¹ The method of working the foot is very simple; supposing that the right foot is under treatment, the heel is grasped

¹ [R. W. Parker has, however, recently recommended and successfully practised subcutaneous section of the inner tarsal ligaments, and particularly of the astragalus-scaphoid.]

firmly with the left hand, the fingers being on the inner side and the palm of the hand pressed against the outer surface of the os calcis; the front of the foot is held by the extremities of the metatarsal bones, and then steadily dragged outwards as far as possible, again relaxed and brought over, and so on, as long as may be thought desirable; no pain should be given by using too much force, and the exercise must be slow and methodical. The value of these manipulations in reducing severe inversion of the foot is very great, whilst from their extreme simplicity they can easily be practised by any person possessed of ordinary intelligence. It may happen, in severe cases, that the inversion of the front of the foot is contributed to by contraction of the plantar fascia; if this is the case, the resistance offered by the fascia, when endeavoring to evert the foot in the manner above described, will be readily detected, and the complete reduction of the inversion will have to be obtained during the second stage of treatment.

The *second stage of treatment* is commenced by dividing the contracted tissues in the sole of the foot in the manner already described when discussing the treatment of the first stage of talipes equinus; the instrument used in the mechanical treatment after operation is of the same pattern as the Scarpa's shoe employed in cases of equinus, but the front part of the sole-plate is supplied with two additional cog-wheels, one which moves it from side to side, and another which rotates it so that either side of the plate can be raised or depressed. In applying the instrument, the sole-plate is set to correspond with the deformity; by means of one cog-wheel it is lowered to a degree equal to the shortening of the sole, by the second it is turned inwards to accommodate it to the amount of inversion that may be present, and by the third the inner border is raised to the extent of rotation that is required; the heel-piece is next adjusted to suit the condition of equinus that exists. Having applied the instrument to the limb, first fastening the heel, then the leg, and finally the front of the foot, the three cog-wheels in the sole-plate are brought into use to draw the forepart of the foot, as much as can comfortably be borne, towards its natural position. This method of procedure is steadily carried on until the scaphoid and cuboid bones, together with the parts in front, are placed upon the astragalus and os calcis; here again manipulations are of great service in overcoming any deep-seated contraction that does not readily yield to the pressure exerted by the shoe; the foot is held in the manner previously described, and is worked in any direction that may be found necessary; if inversion is the chief feature of deformity still existing, the front of the foot is drawn outwards; should the front of the foot remain depressed, it must be steadily forced upwards; if the outer border is on a lower level than the inner, a twisting movement is required. These manipulations are only applicable to contraction of the ligaments directly connecting the several bones, and the surgeon must assure himself that it is upon this contraction, and not upon shortening of the superficial tissues, that resistance to reduction of the deformity depends; it not unfrequently happens that section of the plantar fascia requires to be repeated a second, or even a third, time in varus of long standing and of severe grade. This second stage of treatment is the most important part in the management of the case; every endeavor must be made to render complete the reduction of the displaced bones in front of the os calcis and astragalus, and thus to restore the shape of the foot itself, before proceeding to overcome the condition of deformity existing at the ankle-joint.

The *third stage of treatment* of advanced varus is practically the same as the second stage of that employed in talipes equinus, so that the account already given need not be repeated; it may be noticed, however, that, being a congenital deformity, the articular surfaces have not been properly devel-

oped, and that therefore the reduction of the deformity at the ankle-joint in the case of varus is not as readily accomplished as it is in acquired equinus, where the joint surfaces are but little affected.

Relapsed Varus.—It not unfrequently happens, especially amongst the class of patients who are treated at hospitals, that congenital varus which has been relieved during infancy, again becomes developed at a later period of life. The necessity for counteracting the tendency to relapse which is present until the normal condition of the muscles of the leg and foot is fully restored, has already been alluded to; it is however not always possible to impress the parents of a child, in whom the deformity has been relieved, with the fact that the cure is not yet completed, and the after-treatment of the case is thus often neglected. To such cases only can the term relapsed varus be correctly applied, but under this title are usually included all conditions of deformity which have been treated in infancy and still exist at a later age, so that cases which have never been completely relieved are improperly described as relapsed cases. Failure in the treatment of varus during infancy may depend upon mismanagement of the operative treatment, or upon want of attention to the instrumental treatment; in the former case, it may be due to tenotomy not having been had recourse to when required to relieve the contraction of the several muscles, or from section of the tendons having been imperfectly performed. Failure arising from defective management of the instrumental treatment of the case results from the use of improper appliances, which are not adapted to maintain the foot in position during the process of restoration. In the treatment of these cases of persistent deformity, the measures employed must be selected according to the particular nature of the case and the age of the patient. The condition of true relapse, if again submitted to treatment at an early age, is readily overcome by mechanical and physiological measures alone; but if some years have been allowed to intervene, tenotomy will probably again be required. Cases which have been only partially relieved from neglect to divide the tendons of the contracted muscles, are always amenable to treatment, which is conducted in a manner precisely similar to that given for the treatment of advanced varus. The most unfavorable condition which the surgeon has to encounter is that resulting from badly conducted operative treatment in the first attempt to relieve the deformity, because in such cases the tendons have usually been hacked about, and instead of uniting cleanly have become adherent to the surrounding tissues. These cases require much care in their treatment; it is not often that recourse to tenotomy is of any avail, but benefit may be gained by section of the plantar fascia, if the foot is much shortened. The adhesions which connect the tendons of the contracted muscles to the surrounding tissues may be stretched by long-continued instrumental treatment combined with manipulative exercises, and in these cases the latter method is a most valuable agent in reducing the deformity; by steadily pursuing this plan, I have restored many cases in which the leg and foot were almost covered with scars, from frequent attempts made to overcome the distortion by dividing the tendons.

Non-congenital Varus.—The development of talipes varus as a non-congenital affection may originate either from paralysis or from spasmodic contraction of the muscles of the leg and foot, the former being by far the most common form of the malady.

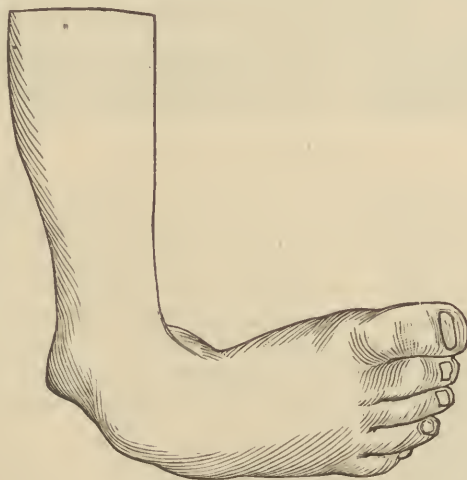
Paralytic varus, in its general character, presents the same condition of displacement as is found in the congenital variety, but there is a marked difference in the appearance of the two forms: in the congenital, the foot is rigidly jointed to the leg and exhibits no indication of weakness; in the non-congenital, it is as it were crumpled up, and looks as though it had been

compressed out of shape from mere inability to hold its natural position. The character of the deformity is shown in Fig. 728; in comparing this case with that of advanced congenital varus, Fig. 727, page 681, it will be observed that the paralytic foot is more displaced at the ankle-joint, but not so much distorted in itself; the cause of this difference depends upon the method of development in the two cases. In congenital varus, the distortion commences at an early period of fetal life, and the bones of the tarsus are dragged out of place by active muscular contraction; in paralytic varus, the flexors and eversors of the foot are deprived to a greater or less extent of their contractile power, and the foot falls into a state of extension and inversion which gradually becomes established as a confirmed deformity, from the pressure brought to bear upon the foot in standing and walking.



Non-congenital talipes varus, the result of *spasmodic muscular contraction*, is more nearly assimilated to congenital varus than is the paralytic condition of distortion. Fig. 729 is taken from a cast of the foot of a boy aged

Fig. 729.



Spasmodic varus.

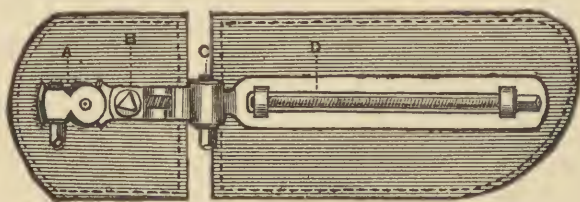
eleven years, who was affected with spasmodic varus; the case presents nothing of the feebleness which is so marked in the paralytic condition, Fig. 728, but it so far differs from the case of advanced congenital varus, Fig. 727, that the distortion of the foot itself is less severe, this, as in the paralytic variety, being due to the fact that the deformity is developed at a period of life when the formation of the foot is fairly advanced.

Treatment of Non-congenital Varus.—In treating non-congenital varus, the same measures are employed as in the reduction of the congenital variety. With regard to *paralytic varus*, the use of tenotomy must be guided by the same laws that have been given when describing the treatment of equinus. Varus the result of *spasmodic contraction* of the muscles, in which shorten-

ing of the muscular fibres has become confirmed, can only be relieved by section of the tendons; but in cases which are submitted to treatment in the early stage of the affection, mechanical and physiological methods are sufficient to overcome the distortion.

Extension in Treatment of Club-Foot.—In the two varieties of club-foot hitherto considered—talipes equinus and talipes varus—there is always present in severe cases of deformity a marked condition of structural shortening of the foot, with contraction of the plantar fascia; during the mechanical stage of treatment, the foot, in order to overcome this shortening, may be kept in a state of extension by drawing the forepart well forward on the sole-plate after the heel has been fixed, but with adult cases, where there is always great resistance to extension, some difficulty is found in retaining the foot in the required position. In order to effectually maintain a state of constant stretching, I have employed a shoe which is a modification of Adams's instrument. Fig. 730 shows the under surface of this appliance; the sole-plate is divided at a point corresponding to the transverse tarsal joint, and is supplied with three cog-wheels, *A*, *B*, *C*, which respectively permit of the

Fig. 730.



Extension-shoe for club-foot.

front part of the plate being moved laterally, raised, and rotated on the heel-piece; the power of extension is gained by the long screw *D*, on turning which the front plate slides forwards. In using the instrument, it must first be adapted to the condition of deformity by means of the cog-wheels in the sole-plate; it is then applied to the limb, being secured in the ordinary manner, and the front part of the foot is extended on the heel by turning the screw *D*. The patient is directly conscious of the stretching of the foot thus obtained, as he feels the foot give at the transverse tarsal joint, and he will

Fig. 731.



Fig. 732.



Severe equinus, before and after treatment.

be able to guide the surgeon in deciding how much extension it is desirable to use, this being to a degree just short of causing pain; having thus extended the foot, the front plate is next raised, rotated, and everted according to the necessities of the case under treatment. I have used this instrument

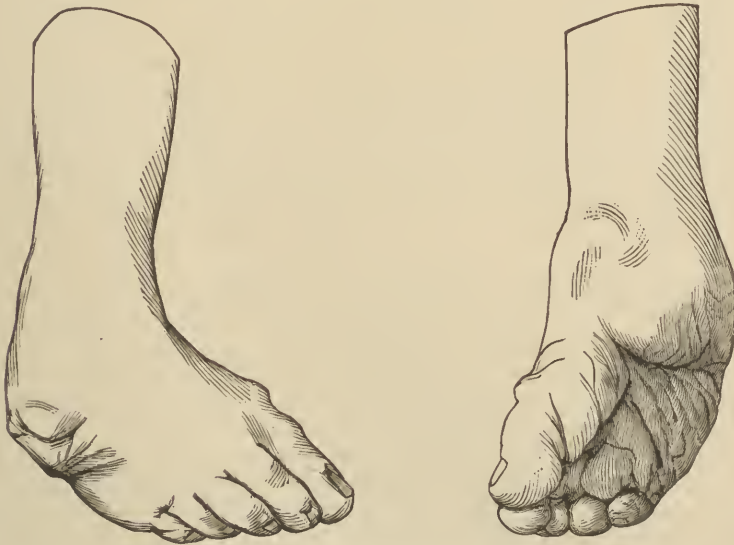
for about four years, and believe that by means of its extending power I have been able to more quickly reduce the distortion of the foot; the two following cases will illustrate the therapeutic value of the instrument:—

CASE I.—This occurred in a man, aged twenty-four, who had suffered in childhood from infantile paralysis which had resulted in the development of *talipes equinus* of the right foot. Fig. 731, a drawing from a cast of the foot, shows the nature of the deformity when he was admitted into the National Orthopædic Hospital. The foot was very rigid, and firmly set in its abnormal condition; the sole was much shortened and contracted; and the instep was greatly raised. The plantar fascia was freely divided, and on the fourth day after the operation the extension instrument was applied; after eight weeks' treatment the distortion of the foot was completely reduced, the result being shown in Fig. 732.

CASE II. was one of *relapsed congenital varus*, in a girl aged 19; both feet were distorted, the right one to a remarkable degree. Figs. 733 and 734 show respectively the anterior surface and sole of this foot: the inversion of the foot was greater than is represented in these drawings, but unfortunately a cast which was taken of the foot before treatment was commenced, was not a faithful copy of the distortion, so that a second one had to be obtained after the foot had been operated on by division of the *tibialis posticus* and *tibialis anticus* tendons, and after about two weeks' use of the outside splint; the part of the foot which was placed on the ground is indicated by the partially absorbed pad in Fig. 733, and from the position of this a fair idea is given of the amount of inversion which originally existed. Fig. 734 is a three-quarter view

Fig. 733.

Fig. 734.



Severe relapsed congenital varus, anterior and posterior views.

of the sole: the compression of the foot was very marked; at the bottom of the sulcus, opposite the transverse tarsal joint, the surface of the skin was folded upon itself to the depth of a quarter of an inch; the forepart of the foot was greatly narrowed; and the metatarsal bones were much displaced. This was perhaps as severe a condition of relapsed varus as has ever been submitted to treatment; the usual course was followed of first overcoming the inversion of the foot, next reducing the contraction of the sole, and finally restoring movement at the ankle-joint. The whole time occupied by treatment was about fifteen months, the deformity of both feet being reduced in this period; some six weeks or so were lost, owing to the patient's suffering from an acute illness which

Fig. 735.



Result of treatment in subject of Figs. 733, 734.

necessitated the intermission of treatment; unfolding of the distortion of the foot itself was accomplished in seven months, which, considering the extreme condition of deformity present and the age of the patient, may be regarded as a satisfactory rate of progress. The result of treatment is shown in Figure 735.

Excision of Tarsal Bones in Talipes Varus.—The method of treating talipes varus which has been described, is that generally followed by those who have studied the practice of orthopædic surgery; some slight differences of opinion exist upon certain details—when to employ tenotomy, the construction of the mechanical appliance used, the respective value of instrumental and physiological methods of treatment—on such points as these unanimity is not to be expected; but the broad principles of treatment are universally accepted, and hundreds of cases could be brought forward to prove that talipes varus, when thus treated, is capable of relief in whatever condition it may present itself. Successful reduction of the deformity can, however, only be obtained by careful observance of the established rules of

practice; even at the present day, it is no uncommon circumstance to meet with cases in which tenotomy has been adopted, but in which the mechanical after-treatment has been entirely neglected, the patient being allowed to walk about without any support within a week or so of the operation, with the natural result of re-establishing the deformity. Again, cases which have been correctly and successfully treated are, from neglect of the patient or his parents, to continue the use of mechanical treatment for a sufficient length of time, found to pass into a condition of relapse. The occurrence of relapse under such circumstances has raised a doubt in the minds of some surgeons as to the efficiency of orthopædic treatment, and more radical measures have been resorted to; it has been said that certain cases are not amenable to the recognized rules of practice, and for such excision of a portion of the tarsus has been employed.

Excision of the *cuboid bone*, in severe cases of talipes varus, was first suggested by Dr. Little;¹ his suggestion was little more than a speculative observation, and this distinguished authority has since expressed his disapproval of the adoption of such an operation. The late Mr. Solly, in the year 1854, acting upon the above suggestion, excised the cuboid bone in an adult affected with severe varus, but the result was not satisfactory. Mr. Lund, in 1872,² excised the *astragalus* in a boy aged seven years, suffering from varus of both feet. The treatment employed before this operation was performed, had consisted in the application of splints and elastic bands, and forcible manipulation under chloroform. The operation was had recourse to under the belief that the chief obstacle to reduction of the deformity was the displacement of the cup of the scaphoid from the head of the astragalus; the case, after a prolonged course of treatment, resulted in the production of a tolerably straight foot, but with very limited movement at the ankle-joint and with persistence of some elevation of the heel. Mr. Davy has removed portions of the tarsus in several cases of club-foot, amongst them one of a child aged sixteen months,³ an age at which few surgeons would pronounce varus to be incurable by tenotomy and mechanical treatment.

¹ Deformities of the Human Frame, p. 305. London, 1853.

² Proceedings of the Medical Society of London, vol. iv. 1879.

³ *Ibid.*

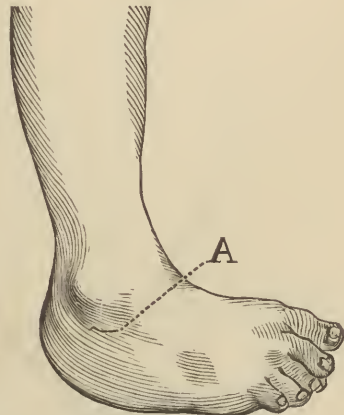
The most instructive case published, in which excision of a portion of the tarsus was performed, will be found in the Transactions of the Royal Medical and Chirurgical Society of London.¹ In this case, that of a boy aged 12 years with relapsed congenital varus of both feet, tenotomy and mechanical treatment were first employed, but these methods were altogether mismanaged; a properly constructed instrument was never used, and the plantar fascia, the tendon of the tibialis posticus muscle, and the tendo Achillis were divided at the same time. The chief interest of this case, however, lies in the fact that an enormous amount of the foot was removed before the deformity could be reduced; the cuboid, nearly all the scaphoid, portions of the three cuneiform bones, of the astragalus, of the os calcis, and of the two outer metatarsal bones were taken away, and even after this free excision of the bones of the foot, prolonged mechanical treatment was found necessary to keep what remained of the member in the required position.

The number of cases of club-foot which have been treated by excision of the tarsus may probably be numbered by tens: those treated according to the rules of orthopædic surgery can certainly be counted in thousands; of the former, two deaths have been recorded as resulting from the operations performed; of the latter, none have terminated fatally, nor has any complication of a serious nature been a source of trouble.

A reference to the reports of several cases in which excision of the tarsus has been performed, after tenotomy had failed to relieve the condition of varus, shows clearly that the deformity had proved to be intractable under a course of treatment which had been followed without regard to the established rules of practice. The error most frequently committed is that of dividing the Achilles tendon alone; also, in a large number of cases, the tendon of the tibialis anticus muscle is divided, but not that of the tibialis posticus; either no attempt is made to relieve the contraction of this muscle, or else the tendon is missed when performing the operation. Another fruitful source of failure is want of attention in conducting the mechanical treatment of the deformity after operation; it cannot be too strongly insisted upon that, in the reduction of club-foot, the operative treatment is of quite secondary importance to the mechanical, and that however skilfully tenotomy may be performed, a successful result will never be obtained unless the after-treatment be most carefully conducted.

The following case is an example of congenital varus in which tenotomy was had recourse to without relief, and in which, the deformity being thereupon pronounced to be intractable to milder measures, the tarsus was excised. W. H., aged 4, applied in the year 1879 to the Surgical Aid Society of London for a walking-instrument to correct a condition of varus of the right foot, for which he had been treated at one of the leading general hospitals from which he was just discharged. Fig. 736, which is copied from a cast taken at the time, shows the condition of the foot; there were numerous scars of punctures over the tibialis anticus, tibialis posticus, and Achilles tendons, and on the outer side of the foot, below and in front of the external malleolus, was another scar about two inches long; this scar, which is marked *A*, is not well shown in the drawing, since, although it is indicated on the cast, it was but imperfectly copied by the plaster. The mother stated that the child had undergone several operations, and that finally some of the bones of the foot had been removed; as will be seen, a considerable degree

Fig. 736.



Relapsed varus after excision of tarsus.

of deformity still existed, the foot being inverted and the inner border completely raised from the ground, while the heel was elevated, and both flexion and extension movements were very limited at the ankle-joint. The parents were naturally reluctant to try the effects of further treatment, but the child was finally admitted to the National Orthopædic Hospital. The case was managed in the ordinary way, and, although some difficulty was experienced in overcoming the immobility of the ankle-joint, the deformity was completely reduced after twelve weeks' treatment. The boy was kept under observation to ascertain if the reduction of the deformity was permanently established, but not the slightest tendency to relapse was evinced, and the condition of the foot, three years after treatment, was that shown in Fig. 737, which is copied from a photograph. I have seen the boy again quite recently; the foot is in excellent position, and there is a very fair amount of movement in the ankle-joint.

Fig. 737.



Same case as shown in Fig. 736,
after orthopædic treatment.

It is probable that excision of a portion of the tarsus may eventually be proved to be of service in the treatment of some conditions of severe congenital varus in the adult, but a more systematic method of performing the operation than has yet been defined must first be introduced; also, a more careful selection of the subjects for operation must be made, and above all, before resorting to the operation, the less severe measures of tenotomy and mechanical treatment must first be correctly employed. The case quoted above from the Transactions of the Royal Medical and Chirurgical Society of London, shows how large a portion of the tarsus may have to be removed before a straight foot (or rather portion of foot) can be obtained; the possibility of a fatal termination must also be considered; and, finally, it must be remembered that the victims of club-foot have often very fair powers of progression: the girl with double varus, whose right foot is illustrated in Figs. 733 and 734, walked so well that the condition of her feet would never have been suspected, and she submitted herself to treatment for relief from deformity, and not for the removal of lameness.

TALIPES VALGUS.—There are two distinct forms of talipes valgus, one of which may be either congenital or acquired, while the other is always non-congenital. The former condition is directly due to muscular disturbance; the latter is the result of defect in the ligaments of the foot, with which muscular contraction may or may not be secondarily combined.

Fig. 738.



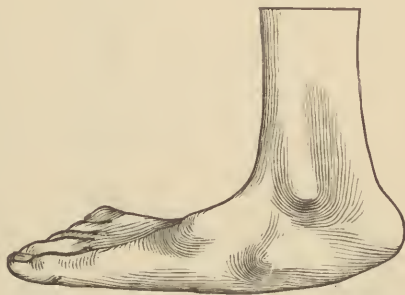
Congenital calcaneo-valgus.

The *congenital form of talipes valgus*, which is due to muscular disorganization and may be considered as true valgus, is, like congenital varus, a double distortion of the foot, and the combination here may be with either calcaneus or equinus. The appearances presented by a case of congenital valgus combined with calcaneus are represented in Fig. 738: the outer border of the foot is raised and everted; the arch is wanting; indeed, the under surface of the inner border of the foot is convex instead of being concave in outline; the foot is flexed upon the

leg, and the heel is depressed. The chief change in the position of the bones of the tarsus consists in displacement of the scaphoid and cuboid bones from the astragalus and os calcis: the scaphoid is dragged outwards and its inner border directed downwards; the cuboid is pulled outwards and upwards; the cuneiform bones, with the corresponding metatarsal bones, are depressed with the scaphoid; whilst the outer metatarsal bones are directed outwards and upwards with the cuboid; the varying position of these bones accounts for the peculiar twisted appearance presented by the foot. The development of this condition of distortion results from spasmodic contraction of the peronei and extensor muscles of the toes, the tibialis anticus muscle being also contracted in severe cases of the nature illustrated in Fig. 738.

The variety of congenital valgus which is associated with equinus presents much the same twisted appearance as the above form of calcaneo-valgus, but the convexity on the inner border of the foot is still more marked; the heel is raised by contraction of the extensor muscles, the centre of the inner side of the foot is depressed from the changed position of the scaphoid, and the metatarsal bones on the outer side are elevated by contraction of the extensors of the toes; the normal condition of the foot, with reference to the parts of the sole which are placed on the ground, is thus almost completely reversed, for that portion which ought to form the arch is depressed, whilst the heel, the outer border, and the forepart of the foot, which ought to constitute the treading surface, are elevated; this condition of deformity is illustrated in Fig. 739. In equino-valgus, the os calcis is more or less elevated according to the extent of contraction of the tendo Achillis, and its position becomes vertical to a corresponding degree; the superior articulating surface of the astragalus is thrown forwards on the dorsum of the foot, the head of the same bone forming a prominence on the inner side; the other tarsal bones are displaced in the same manner as in calcaneo-valgus.

Fig. 739.



Congenital equino-valgus.

Congenital talipes valgus is a deformity which is not frequently met with, but when it does occur, the distortion is usually of a severe nature, the cases above illustrated being fair examples of the condition commonly developed. Congenital valgus, if allowed to continue unrelieved, interferes most seriously with the walking powers of the subject of deformity; the structural changes in the foot are of a much less complicated nature than are those present in congenital varus, but they nevertheless produce greater lameness, because the depressed arch of the foot, which is placed on the ground, is less able to bear pressure than is the dorsum, and also because the protecting pad of thickened skin and cellular tissue, which is developed in varus, is wanting in valgus.

In the *treatment of congenital valgus*, tenotomy is nearly always necessary; in calcaneo-valgus, the tendons of the extensors of the toes and the peronei muscles require division, and it may be also necessary to divide the tendon of the tibialis anticus. No especial directions are needed as to the method of performing section of these tendons: the peroneus longus and brevis are easily reached, and may be divided with one puncture, just above the external malleolus; the extensor tendons of the toes are directed a little in front of the ankle-joint, and for their section the tenotome is entered on the inner side of the proprius pollicis tendon; the method of performing tenotomy on the

tibialis anticus tendon has already been described. Mechanical treatment may be commenced on the sixth day after operation; the reduction of the deformity must not be carried on too quickly, for the divided ends of the tendons of the extensors of the toes separate some little distance from one another, and their union will be weak, or the tendons will be lengthened too much, if extension of the foot be rapidly obtained. The instrument employed is one similar in construction to the shoe used in the treatment of congenital varus; the toe-wire is placed on the inner side of the sole-plate, so that the forepart of the foot may be drawn inwards, and a small pad is added at a point corresponding to the arch, in order to raise the inner surface. In the case of equino-valgus, section of the Achilles tendon is required after the distortion of the foot itself is overcome.

Non-congenital talipes valgus, the result of disordered muscular action, is much more commonly due to paralysis than to spasmodic contraction of the

Fig. 740.



Paralytic valgus.

muscles. The condition of the foot present in a case of *paralytic valgus* is illustrated in Fig. 740; the foot is everted, the inner border is placed on the ground, and the outer border forms a right angle with the outer surface of the leg. The limb exhibits that appearance of weakness which has been noticed as occurring in paralytic varus; the deformity results from paralysis of the tibialis anticus and posticus muscles; the peronei muscles, not being antagonized by their action, produce eversion of the foot on the leg.

There is a condition of paralytic valgus which is not unfrequently combined with equinus, and which requires special notice; in cases in which there has been slight paralysis of the extensor muscles of the toes, or in which the attack has been more severe but in which the muscles have fairly recovered their contractile power, the shortening of the flexor muscles only occurs to

an extent which prevents flexion of the foot to about a right angle on the leg; if with this slight paralysis of the extensors there is also present some loss of power of the tibialis anticus muscle, a tendency to eversion of the foot will also exist, and the deformity of equino-valgus will be developed. The early stage of this condition is generally allowed to pass on without treatment, because very little lameness is produced, and it is considered that what defect in this respect may exist, will disappear as the child grows older and stronger—an anticipation which is seldom realized. With the limited movement at the ankle-joint in the direction of flexion, which is caused by acquired contraction of the extensor muscles of the leg and foot, a considerable strain is thrown on the foot in walking, and as a consequence the mobility of the transverse tarsal joint becomes increased, and an unnatural amount of upward movement of the forepart of the foot on the os calcis and astragalus compensates the loss of flexion at the ankle. The tibialis anticus

muscle being partially paralyzed, the inner border of the foot is not drawn up to the same degree as the outer border, so that the latter becomes raised and the former depressed; eventually the peronei muscles are secondarily contracted and a confirmed condition of valgus is established.

Talipes valgus resulting from *spasmodic muscular contraction* is always associated with equinus, and the condition of distortion is exactly similar to that developed in congenital equino-valgus (see Fig. 739); the forepart of the foot and the heel are often greatly drawn up by the contracted muscles, and it is in cases of this nature that the most severe grade of valgus is met with.

In the *treatment of non-congenital valgus* resulting from muscular disturbance, tenotomy is always required; in the form arising from *spasmodic contraction*, the same course is followed in restoring the foot to shape as in the treatment of congenital valgus, the extensors of the toes and the peronei muscles being first subjected to tenotomy. For the mechanical treatment, a Scarpa's shoe with the divided sole-plate is used; a pad corresponding to the arch of the foot is placed on the inner side of the front plate, and the toe-wire is attached to the same side; the three cog-wheels, giving lateral movement, rotation, and uplifting of the front plate on the heel-piece, are also necessary. By the use of this instrument the forepart of the foot is brought down, the inner border is raised, and the outer border is depressed, the pressure of the pad on the scaphoid at the same time pushing that bone into its proper position; after the deformity in front of the transverse tarsal joint is reduced, the Achilles tendon is divided, and the heel is lowered as in the treatment of equinus. In *paralytic valgus*, mechanical treatment alone should be used if the deformity is not very severe, or of long standing; should muscular contraction have become confirmed, tenotomy must be resorted to, and in most cases section of the peronei tendons will suffice. That variety of paralytic valgus which results from contraction of the Achilles tendon with paralysis of the tibialis anticus muscle, is best relieved by first restoring the shape of the foot by mechanical treatment, and afterwards dividing the contracted tendo Achillis. In discussing the treatment of paralytic equinus, it was remarked that, in young children, tenotomy should not be employed when the heel was only slightly raised, except under certain circumstances; this qualifying statement referred to the coexistence of paralysis of the tibialis anticus muscle. When, therefore, this combination is present, it is always desirable to relieve the limited movement of the ankle-joint if it is found that the transverse tarsal joint is acquiring an abnormal amount of mobility, since otherwise the case is sure to become complicated by the development of valgus.

After restoration of the limb, a steel support fixed to the boot must be used, to assist the weakened muscles in the paralytic, and to counteract the action of the stronger muscles in the spasmodic variety; a steel bar on the outer side of the leg, with a T-strap attached to the inner side of the boot and buckling around the bar, is sufficient in slight cases, but, as with talipes varus, further support must be given by an inside bar, or by carrying the instrument to the thigh, when the distortion has been of a more severe grade.

Flat-Foot.—That form of valgus which is always non-congenital is commonly known as flat-foot; it results from a defective condition of the ligaments of the sole of the foot, and is invariably associated with debility. This affection is frequently met with in rachitic children, and in those who without any special indication of rachitis are nevertheless badly developed, with flabby muscles, and with a tendency to the formation of tissue which is excessive in bulk but deficient in quality. In such cases, the arch of the foot gives way from inability of the ligaments to support the weight of the body; in

the rachitic child, the want of tenacity of the ligamentous tissues which is always present, is the direct cause of the deformity; in the heavy, ill-developed child, the fibrous tissue is not perhaps in such a defective condition as in the rickety infant, but the weight of the body is greater than the feet can support. At a later period of life, boys and girls of from ten to fifteen years of age often acquire flat-foot, especially those of the poorer class, who are badly fed and are obliged to work before they are sufficiently matured to bear the fatigue to which they are subjected. These cases are usually neglected until the arch of the foot is completely depressed, and relief is not sought for until walking causes so much pain that the subject is no longer able to follow his occupation. Pain is generally first felt on the dorsum of the foot, but in some cases the sole of the foot first becomes painful; the pain on the dorsum is due to the upper surfaces of the cuboid bone and os calcis, and of the scaphoid and astragalus, being pressed together; that which occurs in the sole of the foot arises from stretching of the calcaneo-scapoid ligament, and from the pressure which is brought to bear upon the sunken arch. The occurrence of pain is followed by contraction of the peronei muscles and of the extensors of the toes, and this contraction is at first due to reflex irritation; as the deformity increases the muscular shortening becomes permanent, and pain along the affected muscles is added to that already existing.

Fig. 741.



Flat-foot.

When this condition is reached, the foot presents the appearance illustrated in Fig. 741.

The treatment of *flat-foot* in the rickety or debilitated infant may always be successfully conducted by the use of mechanical means alone: a shoe similar to that employed in congenital valgus is required to restore the arch of the foot; after this has been effected, a pad must be worn in the boot to support the weakened foot when the child is standing or walking, and if the case was originally of a severe grade, the use of the instrument must be continued at night. If the deformity has been neglected, the peronei and extensor muscles may require division, in children three or four years of age.

In the early stage of flat-foot, arising in boys and girls who are suffering from debility and who are overworked, the exciting cause must be removed if possible, and a less fatiguing occupation be substituted for that which has pro-

duced the deformity; if placed in circumstances favorable for recovery, the arch of the foot soon becomes restored; pads should be worn in the boots, and the feet should be douched daily with cold water and shampooed on their under surface. If the deformity has progressed to such an extent that the arch is much depressed, mechanical treatment with the Scarpa's shoe, of the pattern used in the treatment of advanced congenital valgus, will be necessary for a few weeks; and when again permitted to use the foot, it is advisable that the patient should wear a steel support on the outside of the leg, extending from the calf to the boot. An excellent method of placing the feet in good position, in the early stage of flat-foot, is one suggested by Dr. Little: the patient sits in the position of a tailor, with the legs crossed and the feet resting on their dorsal surfaces, and by so doing inverts each foot and elevates the outer border; by adopting this position for several hours during the day, cases in the early stage may be cured without the use of Scarpa's shoe or other mechanical appliances. When pain has become developed, there will

nearly always be found considerable contraction of the peronei muscles and extensors of the toes, with inability to invert the foot; but it must not be hastily decided that tenotomy is necessary under these circumstances, because, as has already been observed, the contraction of the muscles may be merely reflex, and may disappear when the foot has been rested and the pain has subsided. A few days' rest, with the foot placed in a Scarpa's shoe, should always be first tried, to ascertain if the contraction of the muscles is due to temporary spasm; if, after this, the shortening still continues, tenotomy must be employed. In the severe grade of distortion illustrated in Fig. 741, the muscular shortening has become confirmed, and no doubt as to the necessity for tenotomy can exist; but even here a day or so of rest is advisable, because the muscles are in a state of excited spasm, and after tenotomy the divided ends of the tendons would separate to a considerable extent, more so perhaps than was desirable. After tenotomy, the foot is gradually restored to shape by use of the Scarpa's shoe in the manner already described; the patient must afterwards be provided with a walking instrument of the ordinary valgus pattern.

TALIPES CALCANEUS.—*Talipes calcaneus* is the least common of the four varieties of club-foot; it occurs as a congenital and as a non-congenital deformity. The *congenital form of calcaneus* is chiefly remarkable for the simple nature of the affection, which is limited to abnormal flexion of the foot upon the leg, without the occurrence of any distortion of the foot itself. In newly born children, the movement of flexion at the ankle-joint is obtainable to a much greater extent than at any other period of life, so that if spasmodic contraction of the flexor muscles is excited in the fœtus, the foot readily becomes drawn into an extreme state of flexion. This condition is illustrated in Fig. 742, the case being that of a baby three weeks old, who was born with calcaneus of the right and equino-varus of the left foot; the shape of the foot is perfectly normal, but the dorsum is almost in contact with the anterior surface of the leg, and the heel is much depressed. This is an example of a severe grade of the deformity, and it has been selected to show what an amount of displacement of the foot upon the leg may occur without the foot itself being distorted; from this condition, calcaneus may vary in degree to one of merely slight interference with the movement of extension of the foot upon the leg. The pathological anatomy of this distortion presents no features worthy of special notice: the bones of the tarsus and metatarsus are in proper relationship one with another; the os calcis is obliquely situated, with its posterior surface directed downwards; the astragalus is drawn backwards under the tibia; the anterior ligament of the ankle-joint is slightly contracted, and the posterior ligament is somewhat stretched and weakened.

Fig. 742.



Congenital calcaneus.

Tenotomy is not often required in the *treatment of congenital calcaneus*, except in severe cases such as that illustrated in Fig. 742, where the tendons of the extensors of the toes must be divided. When the anterior muscles are not much contracted, the deformity yields readily to manipulation and instrumental treatment; the foot may be exercised by drawing it gently down as far as possible into the condition of extension, then flexing and

again extending it; the posterior muscles should also be well rubbed and shampooed to excite their contractile power. For the instrumental treatment, any form of appliance that will keep the foot extended on the leg may be used; the splint employed in the treatment of the second stage of congenital varus answers very well, the foot being extended by means of the cog-wheel which connects the foot-plate with the leg-piece.

Non-congenital calcaneus is usually the result of *paralysis* of the extensor muscles of the foot, and is of a much more serious nature than the congenital deformity, for it combines distortion of the foot itself with altered relationship of the foot and the leg. The character of this affection is

Fig. 743.



Paralytic calcaneus. (After Adams.)

shown in Fig. 743; the heel is depressed, and appears to be much lengthened, owing to the formation of a cushion of hardened skin and thickened cellular tissue on its under surface; the arch of the foot is deepened; and the heel and the ball of the great toe are approximated. In this condition of deformity the *os calcis* is greatly changed in position, its long axis being almost vertical instead of horizontal, and its posterior surface pointing almost directly downwards; the astragalus is carried under the tibia, and its superior articular surface is directed backwards, the head of the bone being turned upwards. This is much the same condition of displacement that occurs in congenital calcaneus; in the paralytic form, however, the forepart of the foot does not retain its position on the posterior section, but becomes bent downwards, and thus causes the depression of the arch before mentioned. The cause of the foot itself becoming

changed in shape in paralytic calcaneus, and not in the congenital variety, depends upon the different manner in which the two conditions are developed. In paralytic calcaneus all the muscles of the leg are found to be affected, the *gastrocnemius* and *soleus* being always extremely wasted, whilst the anterior muscles retain more of their contractile power; the heel thus first becomes depressed from the loss of action of the extensor muscles, and the forepart of the foot is then partially raised by contraction of the flexors, but not to an extent sufficient to correspond to the depression of the heel; the foot is thus bent upon itself at the transverse tarsal joint, being shortened, and its arch abnormally depressed. In congenital calcaneus the development of the deformity originates from excited contraction of the flexor muscles, which draws the foot up towards the leg, and at the same time depresses the heel; and from the mobility of the ankle-joint this depression can be carried to a degree which allows the whole foot to accommodate itself to the acting force without causing distortion at the tarsal joint. Non-congenital calcaneus, the result of *spasmodic contraction* of the flexor muscles acquired after birth, exactly resembles the condition present in the congenital variety; it does not attain to the same degree of severity, on account of the movement of flexion at the ankle being more limited at the age at which it is developed. A condition of deformity of the foot very similar to paralytic calcaneus, is not unfrequently met with as the result of mismanagement of paralytic equinus. If in a case of equinus of the nature illustrated in Fig. 716, the *tendo Achillis* is divided before the contraction in the sole of the foot is relieved, and from want of care the tendon is lengthened too much, the heel becomes depressed, and the forepart of the foot is elevated as in the case of paralytic calcaneus:

the danger of thus substituting a new form of distortion for that previously existing has already been alluded to.¹

Treatment of Non-congenital Calcaneus.—The reduction of the deformity existing in severe cases of *paralytic* calcaneus, such as that illustrated in Fig. 743, can never be completely obtained, but a considerable amount of relief can be afforded by overcoming the contraction in the sole of the foot, and afterwards assisting the paralyzed extensor muscles by means of an appropriate support. The reduction of the distortion of the foot is conducted in precisely the same manner as in the treatment of advanced *paralytic* equinus; but in the state of calcaneus the surgeon has to contend with the difficulty arising from the posterior bones—the os calcis and astragalus—not presenting a fixed base to work upon, as they do when held by the contracted Achilles tendon in *talipes equinus*. After division of any contracted tissues that exist in the sole of the foot, a Scarpa's shoe of the pattern illustrated in Fig. 718 is required for the mechanical treatment; the heel-piece of the shoe must be elevated as much as possible, so as to throw the os calcis and astragalus as nearly as may be in their proper places, and the front of the foot is then raised by means of the cog-wheel in the divided sole-plate. The manipulations previously described for stretching the shortened foot are of great assistance in overcoming this distortion; they may be employed about four weeks after section of the plantar tissues has been effected. When the foot has been so far restored to shape that the sole presents a good treading surface, an instrument must be used to which is attached a spring or elastic band designed to raise the heel in walking; a steel rod extending from the calf to the boot is jointed opposite the ankle, the joint being so constructed that the foot can only fall very slightly below the right angle; from the calf-plate a rubber band may be carried over and attached to the heel of the boot, or a spring may be placed on the side of the bar, which will elevate the heel and take the place of the paralyzed extensors. In the treatment of *spasmodic* calcaneus, tenotomy is required if the contraction of the flexor muscles has existed for some length of time, but as a rule the deformity yields very readily to instrumental measures.

HAMMER-TOE AND HALLUX VALGUS.

The conditions of distortion of the foot that have been described as constituting the various forms of club-foot, are capable of being classified into groups, and although no two individual cases of any one variety present precisely similar features, yet the description of a typical case of each of the different classes suffices to convey a clear idea as to the general character of the particular form of distortion. But there are numerous other deformities of the foot which differ so widely in their nature that it is impossible to assign them distinguishing titles; the foot may in fact be distorted in almost every conceivable manner. Some congenital distortions are due to arrested development: one or more toes, or a considerable portion of the foot, may be wanting; or the ankle-joint may be imperfectly constructed and the foot be in an abnormal position on the leg. The use of improperly fitting boots will give rise to various kinds of deformity; accidents, especially wounds, and burns or scalds, are a common source of distortion; and inflammation of the ankle and tarsal joints may also be productive of displacement of the foot. To this list of exciting causes numerous others might be added; in all the conditions thus induced, the methods of treatment employed in the reduction of the different forms of club-foot will generally be found of value, and a

¹ See page 671, *supra*.

knowledge of those methods will be of great assistance to the surgeon in selecting the best means by which to relieve what may be described as the irregular forms of foot-distortion, which the limits of this article will not allow me to dwell upon in further detail. There are, however, two conditions of the foot not unfrequently met with which may receive separate notice; one of these, commonly called *hammer-toe*, is as a rule an acquired deformity, but may be congenital in its origin, while the other, which has been named *hallux valgus*, results from wearing badly constructed boots.

HAMMER-TOE consists in the contraction of one or more toes into a claw-like position; it most commonly affects the second and third toes. The first phalanx of the contracted toe is drawn upwards, on the metatarsal bone, the second phalanx is bent downwards so that the first phalangeal joint is much above the normal level, while the last phalanx is directed forwards, so that the toe presents the condition shown in Fig. 744. This distortion is a

Fig. 744.



Hammer-toe.

source of much discomfort. A bad corn is always formed on the surface of the angular projection formed by the first phalangeal joint, and the last phalanx is generally very tender; trifling as the deformity appears to be, the subject will gladly submit to amputation of the toe if unable to obtain relief by other means. The *origin* of this distortion is somewhat obscure; like many other conditions of foot-distortion, it gives no trouble in its early stage, and is therefore at first neglected; it is

more common among girls than among boys, and shows a preference for certain families; it is usually developed early in life, and is probably first started by contraction of the flexor muscles. As regards the *treatment* of hammer-toe, when the contraction has existed for any length of time, and has become confirmed, it is remarkably troublesome to overcome. The flexor¹ tendon must be divided, as must also the lateral ligaments of the first phalangeal joint; by this operation the toe can be straightened even up to adult age, but at a later period the joint surfaces are so changed that complete reduction of the distortion is impossible, although it may usually be sufficiently overcome to enable the subject to walk comfortably with a boot made large enough not to press on the front of the foot. After the operation, the toe must be stretched as quickly as possible by means of splints; if two or more toes are affected, a slipper, consisting of a padded metal plate and heel-piece, with slots cut between the toes, so that they can be tied down to the plate, is the most convenient appliance for use in the mechanical treatment.

HALLUX VALGUS is that condition commonly known as bunion of the great toe; it is caused by wearing tight boots, which are too short and too narrow to allow the foot to expand properly in walking. The whole foot is subjected to pressure, both from side to side and from before backwards, and the toes and metatarsal bones, which are the most flexible parts of the foot, become chiefly affected. The great toe is pushed into an oblique position, its ungual extremity being directed outwards and its metatarsal end pushed backwards and inwards, while the metatarso-phalangeal joint bulges out on the inner border of the foot, and a bunion forms over the surface of the joint; the extensor tendon slips away towards the middle line of the foot, and tends to still further drag the toe out of place. The second and third toes

¹ It is somewhat singular that some authorities state that the extensor tendon requires division; this is from the nature of the deformity an evident mistake.

are usually squeezed above the great toe, but in some cases the latter lies upon the dorsal surfaces of the adjoining toes, which are then pressed downwards; the little toe is directed inwards, and the tarsal extremity of its metatarsal bone is often unduly prominent, with another bunion on its surface. This condition of deformity is thus one of mechanical origin; it occurs more commonly in women than in men, owing to the former being more addicted to the habit of compressing their feet with tight boots. The bunion over the metatarso-phalangeal joint of the great toe is liable to become inflamed and ulcerated, and the joint itself, from the pressure against its surfaces, is an additional source of pain which renders walking impossible and completely cripples the patient. The *treatment* of this deformity in the early stage consists in correcting the shape of the boots, and in drawing the great toe into place by means of a splint fixed along the inner border of the foot and carried to the end of the toe. When the distortion is more severe, the tendon of the extensor proprius pollicis muscle requires division; a slipper similar to that used in the treatment of hammer-toe, but with a spring attached to its inner border to invert the great toe, is required; a broad strap should also be passed over the phalangeal extremities of the metatarsal bones, so as to keep the forepart of the foot well spread out on the sole-plate, and the toe must be tied down and kept separated by means of tapes passed through slots cut in the same. After the shape of the foot is restored, the bunion must be protected by a shield of felt, and if thus protected from pressure it soon disappears.

CURVATURE OF BONES.

Curvature of the bones is generally due to rickets, and owing to the prevalence of this disease the deformity is very commonly met with amongst the poor of the large towns in England. Rickets is a general and not a local disease, of which curvature of the bones is only one of the symptoms, and not an essential characteristic; moreover, the deformity occurs in the later stages of the disease, and is not present until the affection is somewhat advanced in severity. Rickets affects infants who have been either improperly or insufficiently fed, and who are exposed to cold and damp, to which causes the development of the disease is generally ascribed by English physicians. It is a common practice amongst the lower classes for women to continue to suckle their children until they are fifteen or eighteen months old; such prolonged lactation is most injurious to the infant. Again, children who are brought up by hand are fed with milk which is largely diluted with water, and are thus deprived of sufficient nutriment; or sickly infants are given, with the view of strengthening them, various foods—such as arrowroot, gruel, potatoes, and meat—which their digestive organs are unable to assimilate. One or other of these errors will in nearly all cases of rickets be found to have been committed during infancy; prolonged suckling has been in my experience the most common cause of the disease, and next to this the administration of different kinds of starchy food. An infant thus circumstanced soon shows symptoms of defective health: sickness and diarrhœa, with swelling of the abdomen, are the first to appear; restlessness at night, sweating of the head, and general tenderness of the body quickly follow; next the epiphyses of the long bones become enlarged, those first affected being the ribs, at their sternal extremities, and the bones of the forearm and leg. There is a general condition of laxity of all the tissues: the skin is pasty, the muscles are flabby, and the ligaments are soft and wanting in tenacity; enlargement of the spleen, liver, and lymphatic glands may also occur, whilst there is a

liability to the onset of various convulsive affections, of which laryngismus stridulus is said to be peculiar to this affection. The bones of the cranium develop slowly, and the fontanelles are late in closing; the skull is prominent at the sides; and the forehead bulges over the face, which is small and shrunken. The thorax is often flattened from side to side in its upper two-thirds, the sternum projecting anteriorly, whilst the lower ribs are expanded; the abdomen is much enlarged, especially below, and the lumbar spine is curved forwards. It is difficult to define exactly the defective conditions which constitute rickets; all the above are general symptoms which, with the exception of the enlargement of the extremities of the long bones, may or may not accompany the disease; in regard to the structural changes also, in the different tissues, there is no marked characteristic to be pointed out, except that present in the extremities of the long bones; there the proliferating cartilage is increased in breadth, and the cells are irregularly distributed instead of being placed in columns.

The period at which rickets is developed is usually between the ages of six and eighteen months, though it may commence at either an earlier or a later period; some authorities state that it exists as a congenital affection, but this assertion requires further investigation; curvature of the bones of the leg undoubtedly occurs before birth, but it does not necessarily follow that such curvature depends upon congenital rickets. The above description of rickets is merely introductory to the subject with which this article is directly concerned—curvature of the bones; there are many further points of interest connected with the disease, which have been fully considered in a previous volume.¹

Rachitic curvature of the bones most commonly affects the *tibia* and *fibula*, and commences at the period at which the child first begins to walk; it arises from the bone-tissue being deficient in earthy matter, which renders it soft and liable to bend. The difference in the proportion of the organic and inorganic constituents of rachitic bone from that which occurs in the healthy state, has been variously given; no doubt it depends upon the condition of disease, the deficiency of the earthy parts fluctuating in amount according to the severity of the affection. The *tibia* and *fibula* are usually bent outwards, the most prominent part of the curves being a little below the junction of the middle and lower thirds of the bones; as the deformity increases, a forward curve of each bone is added to that already existing. The outward curvature of the leg gives the ungainly appearance commonly known as *bow-leg*, whilst the anterior curve causes the heel to appear abnormally prominent; combined with this distortion there is nearly always present rachitic valgus of the foot. The femur also is not unfrequently bent, the curve being formed in the upper two thirds of the bone, in a direction forwards and outwards. The gait of a child thus affected is very awkward: in order to get as wide a base of support as possible, the legs are straddled apart; to accommodate for the forward curve of the bones, the pelvis is somewhat tilted; and to compensate again for this, the upper part of the body is thrown backwards, and a condition of lordosis may become established in the lumbar region of the spine. A rickety infant not sufficiently strong to walk, but able to crawl about on his hands and knees, will develop curvature of the bones of the upper extremity; those of the forearm are chiefly affected, the curves of the bones being directed outwards.

In the *treatment* of rickets the point of first importance is to combat the dyscrasia: a suitable diet must be ordered, and the healthy action of the digestive organs restored; warm clothing and pure air must also be obtained for

¹ See Vol. I., page 255, *supra*.

the infant if possible; as medicinal agents, cod-liver oil and steel wine are of great value. Whilst the bones are still soft, any curvature that may exist is easily remedied; if only slight in degree, and of recent origin, curvature of the tibia and fibula is best treated by stimulating the affected limb with the cold douche and shampooing, and by employing gentle manipulation to bend the curved bones into shape. The latter process is a very simple one: supposing that the right leg is under treatment, it is firmly held by the left hand, with the ball of the thumb resting against the outer side of the leg just above the curve; the lower part of the leg is grasped around the malleoli with the right hand, and the bones are gently straightened, then relaxed, and again pressed outwards, and so on for about ten minutes, the exercise being repeated twice daily. In a more advanced state of deformity, mechanical treatment is required; for this purpose a light wooden splint, which is sufficiently long to reach from the inner condyle to the sole of the foot, must be bandaged to the inner side of the limb; the splint should be slightly concave from side to side, and covered on its inner surface with padding, so that it may fit evenly and comfortably to the leg; it does not in any way interfere with walking, and if firmly and carefully applied, the curvature soon yields to the pressure exercised by the bandage. When rachitic curvature of the bones is allowed to remain unrelieved until the child is advancing in years, and has thrown off the disease, the deformity is much more difficult to overcome, because on the concave side of the affected bone the compact tissue is thickened to an abnormal extent, forming as it were a buttress to support the weakened side of the limb; this over-development of compact tissue may be carried to such an extent, in the tibia, as almost to fill up its concavity, and make the inner surface of the bone nearly straight. This consolidation of the curved bone is seldom present before the subject is from four and a half to five years of age; even in this advanced stage, the deformity may be remedied by the long-continued employment of mechanical pressure, but a more ready means of relief is obtained by resorting to the operation of osteotomy.

Osteotomy, as its name implies, consists in cutting through a bone, by which procedure the surgeon endeavors to convert the case of deformity into one of fractured limb, which may be re-united in a straight position. As at present conducted, osteotomy may be regarded as a recently introduced operation; for although division of the long bones was performed many years ago, it is now attempted to bring the section of a bone into the same class of operations as the section of a tendon, and to include it within the range of subcutaneous surgery. Two methods of performing osteotomy are practised: the bone may be divided with a chisel (or osteotome) and mallet, or it may be cut through with a small saw.

Operation with Chisel or Osteotome.—In 1868, Mr. Stromeyer Little performed osteotomy by means of a chisel, making only a small puncture in the superficial tissues,¹ this being the first operation for which the subcutaneous principle was claimed; the case was one of bony ankylosis of the knee-joint. The bones were separated with a small chisel, one-quarter of an inch in width, and the puncture was afterwards closed with a pad of lint fixed with a bandage, just as the wound in tenotomy is treated; the case progressed without any symptoms of inflammation, and terminated most successfully.² Since this operation was done, considerable advance has been made in the method of conducting osteotomy; amongst others who have contributed to this

¹ On In-Knee Deviation, by W. J. Little and E. Muirhead Little, p. 149. London, 1882.

² The same surgeon, in 1865, operated on a boy in the National Orthopædic Hospital who had curvature of both tibiae; casts of the limbs before and after treatment are deposited in the hospital, and show an excellent result from the operation; for this case, however, the subcutaneous principle was, I believe, not claimed.

result, Dr. Macewen has been particularly successful in his efforts to render the operation one that is safe and easily performed, and has introduced an instrument—the *osteotome*—which is much better designed for cutting through the bone than the ordinary chisel previously used. The osteotome is made of the finest steel, and is very carefully tempered; only the part near the cutting edge is raised to a great degree of hardness, the remainder of the blade being kept soft, so that there shall be no danger of its snapping; it is wedge-shaped and made of one piece of steel, the end forming the handle being octagonal in form, so that it may be grasped firmly, and the top being furnished with a rounded, projecting head; the side of the blade is marked with a half-inch scale, in order that the depth of the cutting edge below the surface may be recognized when the instrument is in use.

In performing osteotomy on the bones of the leg, the limb is steadied on a firm cushion, one filled with sand being the most convenient, and a small longitudinal wound is made with a scalpel down to the tibia, at the point where the section is to be performed; the osteotome is introduced through the wound, and its cutting edge is placed transversely across the bone, into which it is then driven by means of a boxwood mallet. When the section has been carried far enough to enable the operator to fracture the bone, the division is completed in that manner; the fibula is next divided, if that bone is so much curved as to prevent the limb from being placed in good position; some slight bleeding will occur from the bones, but no hemorrhage of any importance is to be anticipated. It is customary to adopt strict antiseptic precautions, but I have usually contented myself with taking care that the instruments used were perfectly clean, and in seeing that the patient was exposed to no septic influence during the operation; as soon as this is completed, the wound is sealed with a pad of lint and evenly covered with a bandage. In order to keep the limb in good position, three light wooden splints, nicely padded, must be provided; one of these is placed on the inner side of the leg, and should be sufficiently long to reach from above the knee to the sole of the foot; a second is placed on the back of the leg, and the third along the outer side, the two latter extending only from the upper part of the leg to the ends of the malleoli. The first splint should be fixed so that it may remain unmoved, whilst the others may be adjusted as often as necessary during the treatment; by means of small pads, placed between the limb and the back and outer splints, the pressure at any spot may be relieved or increased as is found requisite. The after-management of the case is conducted just as is the treatment of a compound fracture of the leg, so that no remarks are called for on this subject; the superficial wounds heal up readily, often by adhesion, and the case usually progresses, to use a familiar expression, without a bad symptom.

Operation with Saw.—In the second method of dividing bone, which is now very frequently practised, the instrument used is a small saw with a double cutting edge, set at the end of a slender shank to which a pistol-shaped wooden handle is attached; this saw was used in 1869 by Mr. Adams, when performing for the first time his now well-known operation of subcutaneous division of the neck of the thigh-bone. With the saw, section of curved rachitic bones can very readily be accomplished; a small knife, shaped like a tenotome, and sufficiently large to make a wound which will admit the saw, is first passed down to the bone at the point where the section is to be performed; down this track the saw is pushed until it reaches the bone, through which it can be made to cut its way very easily.

These two methods of performing osteotomy, with the chisel and with the saw, have superseded all other plans previously adopted. Some difference of opinion exists as to which is the better method; in my judgment each has

its respective merits. Much depends upon the situation of the bone and its anatomical relationship; when near the surface and with no adjacent structures which are likely to be injured, the chisel is perhaps to be preferred to the saw; but when the bone is more deeply situated and has to be reached through a layer of muscles, and care has to be taken to keep the cutting instrument within a well-defined course, the saw is a much safer tool to employ, because it is more completely under the command of the operator; moreover, the saw is so light and handy that it conveys more information to the sense of touch than does the heavier and more clumsy osteotome. Whether these operations are entitled to be described as strictly subcutaneous, is an open question; in dividing the tibia, for instance, with the osteotome and mallet, more can hardly be claimed than that the external wound is a very small one, and much less in extent than the deeper section which is made in the bone, for there is not here sufficient superficial tissue to act as a packing to the chisel, and to prevent the entrance of air to the deeper tissues, the general appreciation of the risk of which occurrence is shown by the fact that most authorities advise that so-called antiseptic precautions should be adopted when operating. When, however, the bone is more deeply situated, and the small saw is used and passed through a track only just large enough to admit it, the surrounding tissues closely embrace it and prevent any air from entering, thus rendering the operation a strictly subcutaneous one. In the above description of the various methods of treatment, reference has been made chiefly to rachitic curvature of the bones of the leg, and it is not necessary to further enlarge upon the general subject by giving the details of treatment necessary in curvature of the other long bones of the extremities, for the same general principles are applicable in all cases. One point is, however, deserving of notice with regard to the development of this affection, viz., as to how far rickets and curvature of the bones may occur independently one of the other. That the former frequently exists without the latter, is very certain, whilst it not unfrequently happens that children have acquired curvature of the bones of the leg who present no indications of the rachitic taint. I believe that the bones may be bent by the mere pressure exercised by the weight of the body, just as the arch of the foot may be broken down to a condition of valgus, and that this condition of curvature may be developed at any period of life between infancy and the completion of growth.

GENU VALGUM.

Genu valgum, or *knock-knee*, is, like curvature of the bones, usually associated with rickets; it is therefore commonly met with amongst the poorer classes in England, and the two deformities are frequently developed in the same individual. Rickets is not the only source of genu valgum: it may also result from debility, from mechanical causes, and from muscular contraction; but as the deformity presents much the same external appearances in all conditions, the rachitic type may be selected for descriptive purposes.

The nature of distortion present in a severe case of *rachitic genu valgum*, is illustrated in Fig. 745, the subject being a boy aged sixteen years. The most noticeable feature of the deformity is the altered relationship of the leg with the thigh, from which the affection derives its title; instead of holding its normal position, the leg is deflected outwards, so that in a case of double deformity, such as that here illustrated, the ankles are widely separated from one another. This eversion of the legs is not so evident when the subject stands in the position ordinarily assumed by those affected with knock-knee, for the thighs are carried obliquely inwards so as to bring the

feet more under the centre of gravity of the body, a practice which, in cases of long existence, induces an abnormal increase in the adduction of the femur

Fig. 745.



Genu valgum.

at the hip-joint. Accompanying the displacement of the leg, the structures surrounding the knee-joint are also involved; thus, on the outer side of the joint the external lateral ligament is shortened and contracted owing to the approximation of its points of attachment, and the tendon of the biceps muscle and the deep fascia are similarly affected; on the inner side, the lateral ligament is stretched and weakened. When genu valgum has existed for some years, the joint-surfaces become changed in shape, the plane of the condyles from side to side being abnormally oblique from above downwards and inwards, whilst that of the tibia slopes upwards and outwards.

Knock-knee, the result of rickets, is directly caused by the lax condition of the ligaments which is so frequently asso-

ciated with that disease. Any one who has frequent opportunities of examining rickety children, may satisfy himself on this point by testing the limbs of those who are markedly affected with the dyscrasia; it will be found in such cases that a very decided amount of lateral movement of the knee-joint can be produced when the leg is fully extended on the thigh, an amount of abnormal mobility which arises from the lateral ligaments being too weak to keep the joint-surfaces firmly braced together. A joint thus loosely knit soon gives way under the weight of the body, and, as the internal lateral ligament is from its construction the least able to resist pressure, the displacement occurs in an inward direction; the oblique position of the femur perhaps also contributes to determine the development of a valgoid knee. When the deformity has been thus started, it usually progresses somewhat rapidly, and in a few months a severe condition of distortion may be established; on the other hand, a more healthy condition of the ligaments may arise, and the displacement may become arrested before much mischief has been caused. The presence of genu valgum in no way interferes with the movements of flexion and extension of the joint, and the subjects of this deformity, even when it exists in a severe grade, possess very good powers of walking; when the leg is flexed to a right angle on the thigh, the distortion disappears, because in this position the contracted structures on the outer side of the joint are relaxed. As has been before remarked, rachitic genu valgum is very often accompanied by curvature of the bones of the lower extremity; there is also always present some enlargement of the bones which enter into the formation of the joint; the inner condyle is apt to be especially prominent, and so is the inner surface of the head of the tibia, the projection of these parts of the bones forming a very marked swelling on the inner side of the joint; exostotic masses of bone are also not unfrequently formed on the inner surface of the shaft of the tibia, a short distance below its head.

Genu valgum the result of debility, is, as far as the external characteristics of the deformity are concerned, very similar to the rachitic variety; it does not, however, attain to such a degree of severity. The subjects of this affection are young children who are overloaded with fat and possessed of somewhat lax tissues, in whom, as has already been noted, talipes valgus is also frequently developed; again, those who have suffered from exhaustive diseases which

have left a permanent condition of weakened health are liable to acquire the deformity. At a later period of life, youths of both sexes, who are employed in occupations which compel them to stand or walk during the greater part of the day, very commonly become knock-kneed, from sheer inability of their joints to withstand the strain to which they are subjected. Many of these cases should rather be classed as of *mechanical origin*, for although a defective state of health is generally produced by such a mode of life, yet it is not uncommon to meet with youths who have acquired genu valgum and yet remain in other respects robust and strong. The development of knock-knee from *muscular contraction* is usually associated with some other deformity of the joint arising from the same cause, and can be more conveniently considered in another part of this article.

Treatment of Genu Valgum.—Genu valgum may be regarded as the simplest of all the deformities of the body which are presented to us for treatment; the distortion does, however, in a few cases assume an intractable character, owing to advanced changes within the joint; these exceptional instances require separate notice, and it will be convenient before discussing them to proceed with the consideration of the treatment of the usual conditions of distortion such as have been described above. Knock-knee is peculiarly amenable to treatment for two reasons: first, the defect in the condition of the joint is remarkable for the simplicity of its nature, and we have not here, as in the case of distortion of the foot, to deal with the serious derangement of a complex piece of mechanism, the separate parts of which require to be restored to place in order to reduce the deformity; secondly, the position of the joint is very favorable for the application of remedial measures, since the thigh and leg form long levers which can readily be utilized for the employment of well-regulated mechanical pressure.

In the early stage of knock-knee, treatment must be directed to restoring the ligaments to a healthy condition, and to preventing those structures from becoming stretched before they have acquired their normal tenacity. Attention to the general health is the matter of first importance, whilst for local treatment the joint should be douched daily with cold water, and afterwards well rubbed and shampooed, especially on its inner surface. If the child is able to walk fairly well, he should be encouraged to use his limbs, and not, as is frequently advised, be kept entirely at rest; if necessary, a light knee-cap, stiffened with steel springs, may be worn to support the weakened joint as long as a tendency to deformity continues to exist. If displacement of the leg is more advanced—to such a degree, for instance, that the ankles are separated three inches from one another when the limbs are extended and placed together—mechanical treatment may be added to the above, by applying splints to the legs during the night, and for a few hours during the day. The splints should be shaped and padded like those already described for the treatment of curvature of the leg-bones, and must be sufficiently long to reach from an inch above the great trochanter to the sole of the foot; they are placed on the outside of the limb, and are firmly fixed with a bandage. In a still more severe grade of deformity the straight splint is not a convenient appliance to use, because it is liable to slip around to the front of the leg and thus lose its purchase; it is for such cases advisable to divide the splint opposite the knee-joint, and to connect the thigh and leg pieces with a cog-wheel which gives lateral movement; a broad knee-cap, extending well above and below the knee, may also be attached to the splint, and will be found of great assistance in keeping the limb in place.

In these more advanced cases of the deformity, the structural shortening of the external lateral ligament is the chief obstacle to be overcome in straightening the leg; in order to hasten the reduction of the deformity it

has been recommended that this ligament should be divided subcutaneously. There is no objection of any importance to be advanced against this operation, but in my opinion a more advisable plan is to stretch the ligament gradually by *daily manipulation of the knee*, a process which is practically as rapid as the more heroic measure of dividing the ligament and puncturing the synovial membrane of the joint. It must be remembered that the relief of knock-knee, to be complete, must include the restoration to its normal condition of the weak internal lateral ligament, and that this result can only be obtained by time; so that, even if the contraction on the outer side of the knee be instantaneously removed, instrumental treatment must be continued until the weakened structures on the inner side have acquired strength, as otherwise the condition of valgus will be sure to return. In manipulating the knee for the purpose of stretching the external ligaments, the joint is held firmly on the inner side with one hand, while the leg is fully extended and grasped just above the ankle with the other hand, and steadily pressed inwards; as much force may be used as the patient can bear without feeling pain, and the limb may be "worked" in this manner for ten minutes or a quarter of an hour every morning and evening; the rubbing and shampooing of the inner side of the joint, as previously described, should be practised before the manipulation.

In the most severe grades of genu valgum, as has already been described, the plane of the articular surface of the femur is often abnormally oblique, owing to partial absorption of the surface of the outer condyle, and to elongation and thickening of the inner condyle. This change in the articular surface of the femur does not much increase the difficulty of reducing the deformity in the case of young children, for nature gradually reshapes the joint-surface as the bones are restored to their proper positions. When, however, knock-knee has been developed in early life and has been allowed to continue unrelieved until the subject is about twelve years of age, the elongation of the inner condyle may become a serious complication of the distortion; fortunately, such cases are of somewhat rare occurrence, and even the severest grade of distortion will yield to the employment of a method of treatment similar to that above described. In the mechanical treatment of these cases, the trough-splint (Fig. 746) more completely controls the limb, and is a more convenient appliance to use, than the simple outside splint. It practically consists of the divided outside splint, with the addition of a foot-piece and of back splints for the thigh and leg; a knee-cap and straps for the purpose of fixing the limb are also added; this instrument requires some little caution in its use, for, from the length of leverage of the thigh and leg pieces, a great amount of force can be brought to bear upon the knee by turning the cog-wheel opposite the joint. The most severe conditions of deformity will yield to the trough-splint and manipulation; the case illustrated in Fig. 745 was treated by this method, and at the end of three months the patient was able to stand and be photographed in the position shown in Fig. 747.

Operative Treatment of Genu Valgum.—In cases of genu valgum which have existed for some length of time, and in which the inner condyle is considerably increased in length, the reduction of the deformity can be more readily achieved than by the above methods, by resorting to an operation on the lower extremity of the femur, for the purpose of rectifying the obliquity of the articular surface. Several different operations have been devised and practised with the object of remedying the hypertrophy of the inner condyle; those which are adopted in the present day differ in some important respects from one another.

In May, 1876, Dr. Ogston first performed the operation which is associated

with his name; in this method the skin is punctured above the inner condyle with a long, narrow knife, and a small oblique wound is made downwards in front of the condyle, through the synovial membrane, dividing the structures in front of the bone, the knife being kept just to the inner side of the crucial

Fig. 746.



Trough-splint for genu valgum.

Fig. 747.



Genu valgum after treatment. (From the same patient as Fig. 745.)

ligaments. Down the passage thus made a small subcutaneous saw (Adams's pattern) is passed, and the bone is sawn through from before backwards, thus separating the inner condyle; the leg is then straightened, the condyle being pushed up to its proper level, where it unites, and the obliquity of the articular surface is thus corrected.

In May, 1877, Macewen modified this operation by removing a wedge-shaped piece of bone from the side of the inner condyle, afterwards pressing together the cut edges of the bone; but in February, 1878, he adopted an entirely different plan, which avoids any interference with the cavity of the knee-joint. In this operation a wedge-shaped cut is made with an osteotome into the lower end of the femur, on its inner side, just above the level of the epiphysis; the exact spot for making the incision through which the osteotome is passed is found by drawing a transverse line, level with the upper border of the patella, and a second, longitudinal line, about half an inch in front of the attachment of the adductor magnus muscle; where these lines intersect is the point for the incision. The bone is cut through until it can be either broken or bent so as to allow the leg to be placed in a straight line with the thigh. The operation is performed antiseptically, and has been practised by Dr. Macewen in a large number of cases without the occurrence of any fatality due to the operation itself; in one or two cases suppuration occurred in the wound, the amount of pus varying from a few drachms to several ounces. Dr. Macewen, speaking of this and other

operations on the bones which he has performed after the same method, says, "the wounds enable the instrument to reach the bone; but as they are generally made more or less obliquely, while the osteotome, after introduction, is turned transversely to the axis of the limb, there is an aperture on each side of the osteotome, leading from the external air directly to the interior of the bone." "They are therefore not subcutaneous osteotomies, but examples of compound fractures and incisions treated antiseptically."¹

Mr. Reeves, in 1878, performed an operation which he describes as being extra-articular: an oblique cut is made with the chisel into the inner condyle, while the leg is flexed so as to draw down the synovial membrane; the condyle is not completely separated, the incision only extending to within one-eighth of an inch of the articular cartilage. The leg is forcibly straightened, and afterwards encased in a plaster-of-Paris bandage which is taken off on the tenth day after the operation, gentle passive motion being then continued daily until the full movement of the joint is restored.²

A fourth operation is that introduced by Mr. Barwell,³ who regards the deformity "not as a mere lengthening of the inner condyle, but as an obliquity of the whole lower epiphysis of the femur," and also says that "in examining the tibia one finds the portion of bone for an inch below the knee-joint perfectly normal; just at that distance below the articulation one feels, in well-marked cases of knock-knee, an angle from which the shin bone slopes outward." To remedy this variety of genu valgum, Mr. Barwell performs osteotomy upon both the femur and the tibia.

Of these four operations, that practised by Dr. Macewen is in my opinion the safest method of procedure to adopt, when in the advanced stage of knock-knee the articular surface of the femur is abnormally oblique. Dr. Ogston's operation has more than once resulted in suppuration within the cavity of the joint, and in one reported case the patient died from septicæmia; again, there is a risk of raising the inner condyle too high, and of producing the opposite condition of deformity—*genu extrorsum*—two instances of which occurrence have come under my observation. In Dr. Macewen's operation the joint is not interfered with, and the danger of failing to correctly shape the articular surface is much less, because the separated portion of bone is larger and better under command than is the small and freely movable condyle. I have also met with a case of genu extrorsum caused by performing Mr. Reeves's operation; the unfortunate termination which attended these three cases could not have been due to any want of skill on the part of the operator, for in each case the surgeon was well experienced in the method of treatment which he was employing. The possibility of thus substituting one condition of deformity for another, by interfering with the joint-surface, is a fact of considerable importance; the condition of genu extrorsum which is thus caused is by no means easy to overcome, and probably the deformity can only be completely reduced by resorting to osteotomy of the outer condyle. A reference to the English medical journals of the last few years shows that much want of discrimination has existed in selecting appropriate cases of genu valgum for treatment by osteotomy. Numbers of young children have been operated on, who could quite as quickly, and much more safely, have been relieved of their deformity by the simple measures of treatment which have been above described.

¹ Lancet, September 18, 1880.

² Transactions of the Clinical Society of London, vol. xii.

³ British Medical Journal, October 18, 1879.

DEFORMITIES OF THE LOWER EXTREMITY FROM MUSCULAR CONTRACTION.

The numerous conditions of non-congenital deformity of the foot which result from nerve-lesion and muscular disturbance, are often accompanied by contraction of the leg and thigh, arising from the same exciting causes. In the case of paralytic talipes, the leg is not uncommonly flexed upon the thigh, owing to the extensor muscles having lost their contractile power, and having been overpowered by the action of the flexors; the biceps is especially powerful in producing this condition of flexion at the knee-joint, and in many cases this muscle also rotates the leg outwards, and everts it, thus inducing a condition of genu valgum. Flexion of the thigh upon the pelvis is caused by the unbalanced action of the psoas and iliacus muscles; the limb is also adducted by the contraction of the inner muscles, and the tensor vaginae femoris and sartorius muscles are frequently shortened. This state of deformity may be present in both lower extremities, in which case the subject is either entirely deprived of all power of progression, or is only able to crawl about on his hands and knees. In the *treatment* of these cases the several conditions of deformity must be taken in separate stages: first, the deformity of the foot is reduced; next, the displacement of the leg upon the thigh; and finally, the contraction of the thigh on the pelvis. The modes of reducing the various conditions of paralytic deformity of the foot have already been described; the relief of the contraction of the leg is obtained by following similar principles of treatment. When the deformity is of recent origin, physiological and instrumental measures will usually suffice to restore the normal condition of the limb; galvanism, with rubbing and shampooing of the weakened parts, and manipulations to stretch the shortened muscles, constitute the physiological methods that may be employed; for the instrumental treatment, an appliance consisting of thigh and leg pieces connected by a cog-wheel at the knee-joint, and with straps for fastening the limb, is required, so that the leg may gradually be extended to its proper position.

In more severe cases of long standing, in which structural shortening of the flexor muscles has become established, *tenotomy* must be had recourse to as the only method of reducing the deformity; division of the hamstring tendons is easily accomplished, as they stand out very prominently, and are easily felt under the surface of the skin. The tendons of the semi-tendinosus and semi-membranosus muscles should be cut by passing a sharp-pointed tenotome under them, entering on their inner side, and dividing from below upwards, towards the surface; the biceps tendon is divided in a similar manner, but care must be taken not to include the external popliteal nerve in the section. Some contracted bands of fascia are often present on the side of the joint, in which case they also must be cut through. The wounds are treated just as those of tenotomy for club-foot, and the limb is kept quiet for a few days by bandaging it to a splint extending up the thigh and down the leg. Instrumental treatment may be commenced on the fourth or fifth day, extension of the leg being then carried on steadily until the full movement of the joint is restored. Contraction of the thigh upon the pelvis nearly always requires the employment of tenotomy, the muscles most affected being the tensor vaginae femoris, the sartorius, the adductor longus, and the adductor magnus. No special directions are required for these little operations; the tendons of the two first-mentioned muscles may be divided just below the anterior superior spinous process, those of the adductors where they can most readily be felt at the inner and upper part of the thigh. The replacement of the thigh is not always accomplished very easily, even when tenotomy has been freely had recourse to; the difficulty arises from the pelvis not affording a good

bearing upon which to apply an instrument; the best results can generally be obtained by the steady employment of weight-extension, which may be made to draw the thigh down upon the pelvis, and also to abduct it. Manipulations may be practised in the later stages of treatment, and appropriate exercises may be ordered to strengthen the weakened muscles; if the adduction is persistent, and does not yield readily, a good plan is to make the subject sit on a saddle, the width of which may gradually be increased as the contraction is overcome.

A condition of deformity very similar to the above, as far as the position of the limbs is concerned, results from spastic contraction of the flexors and adductors of the lower extremity; the treatment of this distortion necessitates the same course of tenotomy and instrumental means as in the case of paralytic contraction.

The effects of treatment in these cases are usually very satisfactory; even with extreme loss of power of the paralyzed parts, a useful limb can be obtained by overcoming the contraction and placing the weakened muscles in a condition favorable for exercising what amount of contractile power they may retain. When the patient is sufficiently recovered to be allowed to use his limbs, steel supports, extending from a band around the pelvis to the boot, are required; if the extensors of the leg be much wasted, the knee-joints must be fixed by a slip-catch, which will prevent the knees giving way when the child tries to stand. Crutches, or, what is still better, a go-cart, should be used in the first attempts to walk, and as muscular strength is regained, these artificial aids must gradually be removed and the child be encouraged to trust as much as possible to his own efforts. The progress towards recovery is slow, especially when the condition of deformity has existed for some years before being submitted to treatment; the spasmodic cases are the most tedious in their course, but even here much can always be done to improve the walking powers by steadily persevering with the instrumental treatment. A case that was under my care some years ago, in 1878, is a remarkable instance of the power of self-recovery which the muscles possess when restored to a condition which promotes their proper action:—

A young gentleman, aged 18, had suffered from infancy from spastic contraction of the flexors and adductors of the lower extremities; he had never walked, and his only mode of progression was by crawling on his hands and thighs. There were equinovarus of both feet, flexion of both legs, and flexion and adduction of both thighs; he was nevertheless well developed, and much above the ordinary height and weight. The various conditions of deformity were relieved one after the other, and instruments to support the limbs, with crutches, were used in his first endeavors to walk; gradually one crutch and then the second were discarded, and two sticks were substituted; he could, in 1883, walk three or four miles with the instruments and one stick only, and could even get about for short distances without any artificial assistance whatever.

DEFORMITIES OF THE UPPER EXTREMITY.

Contraction of the *hand*, *forearm*, or *arm*, may result from muscular disturbance, and may be present either as a congenital or as a non-congenital affection. The congenital deformities of the hand have been compared with those occurring in the foot; thus, when the hand is flexed and pronated, owing to shortening of the muscles which produce those movements, the distortion has been regarded as of a nature similar to talipes varus; again, when the extensors and supinators are contracted, a comparison has been drawn between the state of the hand and talipes valgus. Congenital contraction of the hand is seldom of a severe nature, although a slight degree of muscular disturbance

is often met with; tenotomy is consequently very rarely necessary, and the use of a small flexible splint, similar to that employed in the treatment of slight varus, will soon overcome the contraction. Non-congenital affections of the upper extremity are usually due to muscular paralysis; these cases present no special interest, and scarcely admit of any classified description. Their treatment is conducted on the same plan that is employed in paralytic deformities of the lower extremity, and here again mechanical treatment usually suffices without tenotomy.

DUPUYTREN'S CONTRACTION OF THE FINGERS.—This affection, which has been named after the eminent French surgeon who first explained its pathology, is characterized by flexion of the fingers upon the palm of the hand. Dupuytren, having obtained for dissection the hand of a subject of this contraction, proved that the muscles and tendons took no part in producing the deformity, for he found that the palmar fascia was shortened and contracted, and that after dissecting off this structure, the fingers could be perfectly straightened; nor did further examination discover any abnormality of the tendons or joints. This disease usually commences with slight hardening of the palmar fascia in the middle of the palm, below the ring and little fingers; the skin next becomes slightly adherent and dimpled, being somewhat thickened around the depression. The induration of the aponeurosis and skin progresses until a band of thickened fascia can be felt passing upwards towards the base of one of the fingers. This band increases both in width and depth, until it is clearly displayed beneath the skin when the finger is pressed backwards to its full degree of extension; the finger next becomes drawn forwards, and is held by the contracted band in a straight

Fig. 748.

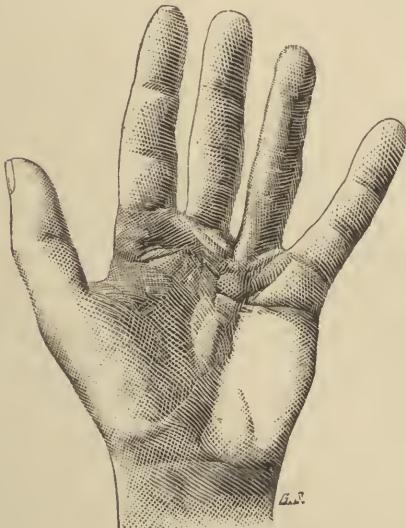
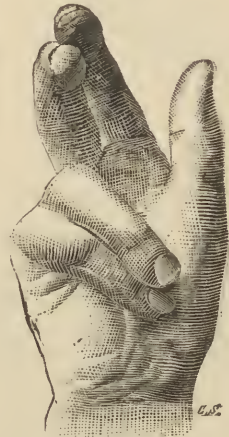


Fig. 749.

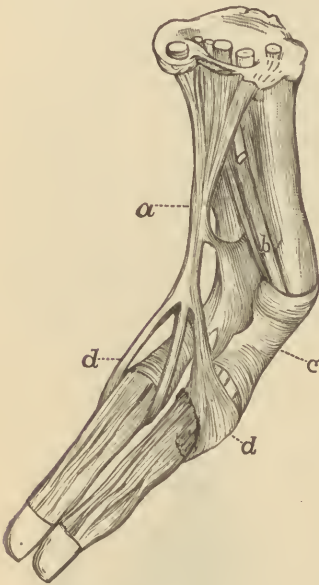


Dupuytren's finger-contraction.

line with the metacarpal bones, and gradually the movement of extension becomes more and more limited until the finger is brought down to a condition of flexion. The contraction usually commences by bending of the first phalanx on the metacarpal bone, the second phalanx being afterwards

drawn down upon the first; generally, too, it affects one finger, either the ring or little finger, much more than the others; but much variation occurs in these respects. It is rare to find more than three fingers included in the deformity, but any one may be contracted, or all, including the thumb, may be implicated in one hand; the finger which most frequently escapes is the index finger. The condition of the hand in the early stage of the affection is shown in Fig. 748; the broad band of fascia extending from the palm to the ring and middle fingers is clearly seen, as well as the commencing flexion of the first phalanges of the affected fingers upon the metacarpal bones. Fig. 749 illustrates a more advanced state of the deformity, the fingers here being contracted also at the first phalangeal joint, and so much drawn downwards that the band in the palm of the hand is almost

Fig. 750.



Dissection of Dupuytren's finger-contraction. (After Adams.)

hidden from view. Fig. 750, which is a drawing from a dissection in St. Bartholomew's Hospital, London, shows the contracted band of fascia in the palm (*a*), with prolongations extending to the joints of the first and second phalanges of the middle and ring fingers; the flexor tendons are seen at *b*, passing into the sheath *c*. This drawing very clearly illustrates the pathological anatomy of the affection, and proves how entirely the contraction of the fingers is dependent upon changes occurring in the palmar fascia, and that it is not in any way contributed to by shortening of the tendons.

Upon what *cause* the development of this contraction of the palmar fascia depends, has not yet been clearly made out; it has been described as an affection of purely local origin, arising from constant irritation of the palm of the hand in manual labor. Adams, who has most carefully studied the nature and treatment of the disease, controverts this theory and leans strongly to the opinion that it is of constitutional origin, regarding it as depending upon a gouty diathesis.¹ He says that, in the majority of cases, there is "a well-marked family history of gout, although the patients suffering from contraction of the fingers, in many instances, have not themselves suffered from gout in any form." Mr. Adams further remarks that he has seen "but very few cases of Dupuytren's contraction in the laboring class, and has failed to obtain evidence of its frequent occurrence amongst any particular class of mechanics; whilst the cases that did present themselves, generally occurred in butlers and indoor servants."² He further calls attention to its prevalence amongst the upper and middle classes of society, to the fact that it frequently occurs in the left hand only, and also to its not uncommonly being an hereditary affection. That this affection is almost always associated with gout is supported by my own experience; of the few cases that have been met with at the National Orthopædic Hospital, all exhibited well-marked symptoms, or a clear family history, of gout. In private practice, one patient only has failed to show any history of the constitutional

¹ Observations on Contraction of the Fingers, etc., page 20. London, 1879.

² Op. cit., page 22.

disease, either personal or hereditary; this gentleman had lived an active life for many years, and it was after his settling down to a more quiet and sedentary mode of life that the contraction of the hand became developed; probably therefore it was here due to gout, but was the sole indication of the disease, which may yet display itself in a more pronounced manner.

Local irritation has, nevertheless, some influence in producing the palmar contraction, and in regard to this point two cases which have come under my observation are worthy of notice. In the first case, a gentleman who up to the age of about fifty years had been in the habit of riding and driving a great deal, was affected with slight thickening of the fascia, with dimpling of the skin on the palms of both hands, without however suffering from any symptoms of gout. Shortly after this slight contraction appeared, this gentleman so changed his practice as almost entirely to give up either riding or driving; the Dupuytren's disease became arrested, but soon afterwards other well-marked symptoms of gout were developed. In the second case, a gentleman whose occupation was purely of a professional character, and who was addicted to no further manual labor than is usually associated with the ordinary course of life, had, before retiring into private life, suffered from gout; living afterwards in the country, and devoting himself with some enthusiasm to gardening and such like out-door pursuits, he acquired well-marked contraction of the palmar fascia in both hands, the other gouty symptoms at the same time almost entirely disappearing. These cases, and others of a similar nature which might be quoted, prove distinctly that the influence of a local excitant must not be disregarded in investigating the origin of this disease; the fact that in the first case a discontinuance of using the reins¹ was followed by a cessation of the advance of the contraction of the fascia, and that in the second case the use of gardening implements was necessary to start the disease, shows that in the gouty subject local irritation will very probably act as the exciting cause of this affection; whilst the fact that it is nearly always accompanied by gout, indicates that the latter is its chief predisposing cause.

The time of life at which this contraction commences is usually between the ages of thirty and forty years, but it may begin at an earlier or later period. It is rarely met with in women; I have seen three such cases only, one of which has furnished Fig. 749, the subject being a woman who was markedly affected with gout, and whose occupation was that of a charwoman; another of these three cases was in a woman in a humble station of life, who was in the habit of using her hands in somewhat rough work; whilst the third was in a lady, in whom, however, the disease did not assume a very aggravated form. A condition of finger-contraction which is very common to the female sex, and which is often mistaken for Dupuytren's contraction, may here be referred to. The deformity is nearly always congenital, or of a very early origin; it is usually met with in the little finger only, and affects the first phalangeal joint; there is no contraction of the fascia of the palm ever present, and the condition seems to be somewhat closely allied to hammer-toe.

Treatment.—Except in the very earliest stage of contraction, the relief of this affection can only be obtained by subcutaneous section of the fascia. So effectual is this method of treatment, and so superior is it to all other methods practised, that I feel justified in proceeding at once to a description of the mode of operation, and of the necessary mechanical treatment to be afterwards adopted. The procedures here given are those established

¹ It may be stated that the gentleman here referred to was in the habit of keeping horses that required to be really driven, and not merely guided.

by Mr. Wm. Adams, of which a detailed account will be found in the work already referred to ; from my own personal experience of this method of treatment, and from having fortunately been able to watch the practice of Mr. Adams himself in the management of a large number of cases, I can assert that all conditions of this affection, of whatever severity they may be, are capable of relief. To obtain success, however, some knowledge of the use of mechanical appliances, and an aptitude in the performance of the subcutaneous section of contracted tissues, are necessary ; for there is perhaps no condition of contraction, the treatment of which so much requires facility in the employment of orthopædic practice, as does that of Dupuytren's contraction of the fingers.

Taking, for the purpose of description, a case similar in its nature to that illustrated in Fig. 749, the operation is commenced by first dividing the contracted bands of fascia which are present in the palm, and afterwards dealing with the prolongations upwards to the phalanges. An anæsthetic must always be given unless there is some grave objection to its administration ; in the first place the operation is a very painful one, and in the second it is very necessary that the hand should be kept perfectly still, and that the surgeon should have complete command of his knife. The knife used must be one with a very small blade and a straight-cutting edge ; the fascia is first divided as near the wrist as can safely be done without risk of wounding the superficial palmar arch. The puncture is made about an eighth of an inch to the ulnar side of the contracted band ; the blade is worked forwards between the skin and the fascia, and when the band is quite covered by the knife, the edge is turned and the fascia is divided. Care must be taken not to depress the point of the knife so as to wound the digital arteries or the flexor tendons ; but of this there is little danger, as the contracted fascia is tensely strained across the hand, and is quite a quarter of an inch above the deeper structures. Having perfectly freed the contraction at this point, the wound is covered with a small pad of lint or other material, and pressure is kept up by the finger of an assistant. A second section is made about midway between the first incision and the base of the flexed finger, the same mode of procedure being followed. These two incisions will probably completely overcome the contraction in the palm, but if necessary a third or fourth must be made, until this part of the hand is quite relaxed. The surgeon will best assure himself of the completeness of this part of the operation by extending the fingers as far as possible, and carefully feeling with the point of the finger for any small fibres of fascia that may have escaped his notice. Having completed the palmar portion of the operation, the pads over the wounds are fixed by strapping ; extra pressure is made by a few large pads over the smaller ones, and the whole are firmly, not tightly, secured with a bandage. The prolongations to the fingers are next divided ; usually, lateral bands will be found on each side of the first phalanges, and must be divided by separate incisions, each cut being closed as soon as the section is completed, as was done in the palm. The first phalanx should now be capable of being brought into its normal position with the hand ; if the second phalanx is drawn down upon the first, more lateral bands will be found extending to its base, and must also be divided. The pads on the wounds are next secured, and the bandage is carried round the fingers that have been operated upon. A flexible metal splint, long enough to reach about three inches up the forearm, and to the ends of the fingers, is next applied as in the case of tenotomy ; the fingers may be straightened as far as can be done easily, but it is not desirable to attempt to get them quite straight at this stage. The extra-pressure pads may be removed on the day following the operation, but no haste should be

exhibited to take off the small pads which close the wounds; these may be taken from the fingers on about the fourth or fifth day, and from the palm on the seventh or eighth day.

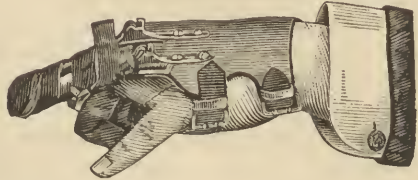
On the fourth or fifth day after the operation, mechanical treatment must be commenced. The construction of the instrument to be used will be best understood from the accompanying illustration; it is attached to the back of the hand, and consists of a plate covering the dorsum, to which are attached steel pieces with extension-racks corresponding to the joints of the fingers; straps for fixing the appliance are also added. The extension must be carried on as rapidly as possible, but great care must be exercised not to cause sloughing of the skin by using too much pressure; it is just at this point that the mechanical ability of the surgeon will be tested: if he proceed too hastily, the skin will give way, and time will be lost in waiting for the sloughs thus caused to heal; whilst if too slow progress be made, recontraction will take place before the fingers are fully extended. In an ordinary case, such as that here being considered, the normal extension of the fingers should be obtained in about three weeks. After this stage is reached, the instrument should still be worn for a time, or a lighter form of apparatus may be substituted for it. Some stiffness of the fingers will remain after the contraction is overcome, but this is soon removed by soaking the hand in hot water, and rubbing it freely with neat's-foot oil or some similar lubricant. When more than two fingers are badly contracted, it is desirable to commence treatment by operating on only a portion of the hand; thus, if the whole of the hand is affected, the thumb and index finger may first be freed, and the remaining fingers treated after an interval of two weeks.

Dupuytren's contraction, like all other forms of contraction with which we have to deal, will relapse if the section of the shortened bands is not thoroughly effected at the first operation, or if the mechanical treatment is not systematically proceeded with. If carefully carried through, the treatment of these cases always yields a most satisfactory result. An interesting feature is the very thorough manner in which nature removes the hardened and contracted tissues; not only does the fascia become reduced to its normal condition, but the thickening of the skin also disappears, a result which is probably due to the free division of the tissues which is involved in the operation.

LATERAL CURVATURE OF THE SPINE.

The subject of lateral curvature of the spine is one upon which much has been written, and upon which many different opinions have been expressed. The etiology of this deformity has never been clearly made out, a failure which has been ascribed to the fact that, as the disease is one essentially of a chronic nature, the investigator has to encounter the serious difficulty of being unable to obtain for necroscopic examination a spine in the early stage of the affection; whether or no this explanation be correct, the fact remains that no two writers on this subject will be found in complete accord, and as a result of this diversity of opinion upon the causation of the deformity, an equal want of harmony exists with reference to its treatment.

Fig. 751.



Instrument for Dupuytren's finger-contraction.
(After Adams.)

Lateral curvature of the spine is of very frequent occurrence, the subjects most liable to the deformity being females, in whom there would appear to be a special tendency to the formation of curvature at two periods of life: first, during early childhood, and secondly, during early adolescence. Except that it may be considered a disease which especially affects civilized communities, it is not limited to any particular class of humanity; it is generally said that the complaint is principally to be met with amongst the better classes, and therefore in those addicted to habits of luxury; but there can be no doubt that the poor are frequently the subjects of lateral curvature: of the three thousand cases of deformity already alluded to as having been classified from the patients attending the National Orthopædic Hospital of London, in 937 there were affections of the spinal column, and of these 353, or nearly 38 per cent., were examples of lateral curvature.

NATURE AND CHARACTERISTICS OF DEFORMITY IN LATERAL CURVATURE.—The spine is liable to become curved laterally either in the cervical, dorsal, or lumbar regions, but the most frequent seat of curvature is in the lower two-thirds of the column, that is, below the fourth dorsal vertebra. The situation and condition of distortion are greatly varied in different cases; thus there may be one long curve extending through several vertebræ, with another short curve; or there may be two curves of equal length, and so on; but in whatever part of the spine the curvature may be located, the structural changes at the seat of curvature will invariably present the same characteristics, and will differ only in degree. The changes in the condition of the spine which constitute the deformity are well marked; it will be convenient to inquire first what are these changes, and to examine the morbid anatomy of lateral curvature, before considering the symptoms and appearances presented during life; for much confusion has arisen from a want of discrimination between other affections in which lateral deflection of the spine exists, but which differ most materially in their nature from true lateral curvature.

PATHOLOGICAL ANATOMY OF LATERAL CURVATURE.—The condition of the spine when curvature has been formed, is somewhat remarkable; if the anterior surface of the column be examined, it will be found that the vertebræ are displaced from the median line, the extreme point of deflection being usually at the middle of the curve. The natural relations of the bodies of the vertebræ, throughout the curve, are so altered that their surfaces on the side of concavity are brought abnormally close together, whilst on the convex side they are unduly separated—a condition which is the natural consequence of the bending of the column. In addition to this, the vertebræ are changed in position in such a manner that their anterior surfaces are directed laterally, and face towards the convexity of the curve instead of directly forwards. On examining the posterior surface of the spine, the curve will be found to be much less marked than on the anterior surface, and the lateral displacement of the spinous processes will not be proportionate to that of the bodies of the vertebræ. This excess of displacement of the anterior portion of the column is commonly described as “horizontal rotation of the vertebræ,” from the fact that the segments of the spine present the appearance of being turned around on their axes.¹ From the occurrence of this peculiar condition of distortion, the spine looks as though it had been twisted, wherefore the use of the term lateral curvature has been objected to, and others, such as serpentine

¹ The term “rotation of the vertebræ” is open to objection, but it has become established by use, and will be employed in this article to express the condition to which it has been ordinarily applied. The reasons for objecting to the term are referred to under the subject of etiology of lateral curvature.

curvature, rotary curvature, and rotato-lateral curvature, have been suggested; it is hardly worth while, however, to give up a term which has become established by use, merely to adopt a phrase which more fully conveys by its meaning the precise nature of the deformity; and indeed the term lateral curvature is not incorrect, for the twisted appearance of the column is simply due to the anterior portion of the spine being displaced to a greater degree than the posterior.

The disturbance of the relative positions of the vertebræ at the seat of curvature, of necessity affects the direction of the transverse processes: these become on the convex side of the curve directed backwards and separated from one another; on the opposite side they are thrown forwards and brought into closer apposition. The articulating processes are also influenced by the change in position of the several bones, for the weight of the body is no longer carried directly through the bodies of the vertebræ, but is directed laterally, and an undue amount of force is brought to bear upon the articular processes on the outer side of the curve; it will readily be understood that under this extra pressure these processes give way and become absorbed, since at the period of life at which curvature is formed they are not fully developed, and have but little power of resisting the strain to which they are subjected.

Changes in Intervertebral Disks.—The changes which are found in the soft parts of the column can be described in a few words, but although thus capable of being briefly noticed, they are, as respects the condition of the intervertebral disks, well worthy of consideration. These bodies being firmly united to the surfaces of the vertebræ between which they are interposed, are rotated in a similar manner with the vertebræ at the curved portion of the column; they also become compressed on the concave side of the curve and stretched on the opposite side, so that they are wedge-shaped from side to side, the base of the wedge being on the side of convexity. Together with this change in shape, it is highly probable that their physiological function is interfered with, and that they do not possess that elasticity which pertains to them when in the normal state. Of the other ligaments of the spine, those connecting the transverse processes—the inter-transverse—are the strongest of the lateral ligaments of the column; they are shortened on the concavity and lengthened on the convexity of the curve; and the same condition exists in the fibrous bands which connect the bodies of the vertebræ and form the lateral ligaments of the spine.

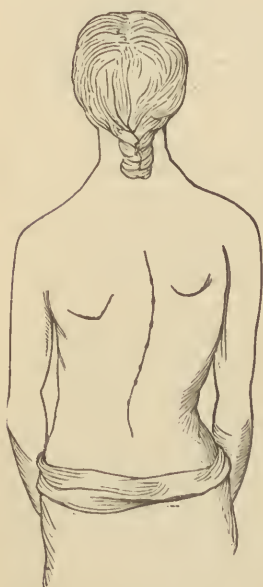
CLASSIFICATION OF CASES.—These then are the chief points to be noticed in the anatomy of lateral curvature; the external characters of the deformity in the living subject, and the effects produced upon the body by these changes in the structure of the spine, have next to be considered. In describing the external characters of lateral curvature, it is customary to classify the cases according to the nature of the displacement. The method usually adopted of grouping cases under the nomenclature of single curvature, double curvature, triple curvature, etc., according to the number of curves formed in the column, is decidedly open to objection; in no two instances will the condition of curvature present precisely similar features, so that if several cases of so-called double curvature are compared, they will be found to differ greatly in character. Some arrangement is, however, necessary for the convenience of description, and perhaps the most practical way of treating the subject will be to make a regional classification, and to consider first the condition presented by the formation of curvature in the lower two-thirds of the spine, which, as before stated, is the most frequent seat of deformity, noticing afterwards the more uncommon forms of the affection.

Lateral curvature below the fourth dorsal vertebra consists generally in the formation of two curves, an upper or dorsal curve, and a lower or lumbar curve; but although it is convenient to thus distinguish the two curves by the terms dorsal and lumbar, these descriptive titles are not always accurate, for the upper curve may extend below the dorsal region and include one or more of the lumbar vertebræ, or again the lumbar curve may include some of the lower dorsal vertebræ. It is this variation in the length of the curves which gives rise to such a marked difference in the external characters of cases of lateral curvature; to describe all the varieties which the deformity may assume would be impossible, but an examination of the condition presented in three types of the affection will give a fairly representative analysis of the changes which result from curvature of the spine below the fourth dorsal vertebra.

The three conditions of deformity most frequently met with, differ as to the length of the curves in that, in the first, the upper curve is longer than the lower; in the second, the proportions are reversed, the lower curve being longer than the upper; and in the third, the curves are about equal in length. These three classes of cases show certain differences in their external characters: in each the curvature of the spine alters considerably the shape of the trunk, for the vertebral column, like the keel of a ship, is the foundation of the structure, but in the two classes which present an unequal length of the curves the changes are most marked, and of these two the greater deformity results in the first class, in which the upper curve is larger than the lower.

1. A case of lateral curvature in which a *long upper curve* to the right side

Fig. 752.



Lateral curvature of spine: long upper curve.

and a *short lower curve* to the left have been formed, is represented in Fig. 752; the most obvious change, and the one that first attracts notice, is the *want of symmetry presented by the contour of the body*, so that the outlines of the two sides are markedly different, and on neither is the natural shape of the body preserved. On the right side the wall of the thorax is unnaturally bowed out, whilst the hollow of the flank is abnormally deepened; on the left the whole side is flattened, and the outline exhibits a shallow curve from the arm to the hip; the right shoulder is also higher than the left, and the right hip more prominent. This disturbance of the due proportions of the trunk is caused chiefly by displacement of the ribs, and a consequent alteration in the shape of the thorax; in reviewing the pathological anatomy of lateral curvature it was noticed that the transverse processes of the "rotated" vertebræ were on the convex side directed backwards, and on the concave side thrown forwards; in the dorsal region the altered direction of the transverse processes throws back the ribs on the convex side of the curve, causing their angles to bulge out posteriorly, whilst their shafts and sternal extremities are drawn backwards, giving rise to a depression of the walls of the thorax in front. On the concave side

of the curve the reverse conditions exist, the angles of the ribs are carried forwards so that the posterior wall of the chest is flattened, the shafts of the ribs are pushed forwards, the costal cartilages become bent, and an undue *prominence of the thorax* is the result. The condition of displacement here

described will be more readily understood by referring to the accompanying diagram (Fig. 753), in which the dark line represents the normal outline of the thorax on transverse section, and the lighter line the change produced by the altered position of the vertebræ in lateral curvature. A further change in the position of the ribs is also produced, which affects the shape of the thorax: on the concave side of the curve their oblique direction is exaggerated, and they become crowded together and pushed downwards so that the last rib is brought abnormally near to the crest of the ilium; on the convex side the oblique direction is lost and the ribs are directed horizontally, the intercostal spaces being widened and the capacity of the chest apparently increased.

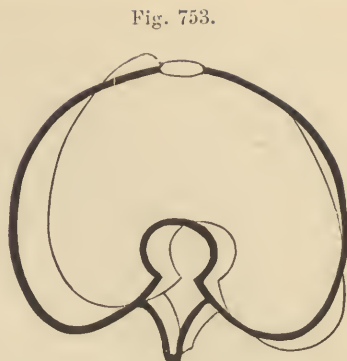


Diagram of thorax in lateral curvature.
(After Shaw.)

The deepening of the flank on the right side and the flattening on the opposite side, are dependent upon the displacement of the lumbar vertebræ, the bodies of which are turned towards the left side, whereby the abdominal walls fall in on the right side and give an appearance of *undue prominence of the crest of the ilium*. The apparent protrusion of the right ilium is commonly spoken of as "growing out of the hip;" it often first attracts the attention of the patient, and is the cause for which relief is sought from the surgeon; the latter should not of course be deceived by this condition, but mistakes are occasionally made, such as treating the case as one of hip-joint disease, or ordering a high boot to be worn under the supposition that the leg is shortened.

Besides these changes in the outline of the trunk, there are important features to be noticed with reference to the surfaces of the body: on the posterior surface, to the right of the lumbar spine, a groove is formed from the altered direction of the transverse processes; this depression results from the *muscles sinking in* with the rotated transverse processes, and not, as sometimes supposed, from wasting of these muscles; on the left side, in the corresponding region, there is found a prominence caused by the muscles being thrown into strong relief and pushed backwards by the projecting processes on this side. In the dorsal region, the most striking abnormality is the position assumed by the *scapulae*: the right scapula is unusually prominent, and is directed outwards, its lower angle being especially noticeable—a condition which is due to the altered shape of the thorax, and to the bone slipping above the upper borders of the *latissimus dorsi* muscle; on the left side the scapula is less prominent than natural, owing to the flattening of the thorax; its inferior angle is depressed, and is on a lower level than the bone of the opposite side. On the anterior surface of the body the changes are not as well marked as on the posterior surface; the *breasts* will, however, be often found to be placed unsymmetrically, the left being more prominent and raised higher than the right; a peculiar twisted appearance of the *abdomen* is also met with, the *umbilicus* being displaced from the median line, and there being a greater fulness on the right than on the left side. The chief variations from the normal condition on the surfaces of the body will thus be seen to be, an undue prominence of certain parts on one side and a depression of the same organs on the opposite side; of these conditions, the first, it will be noticed, arises on the convex side of the curve of the spine on the posterior surface, and on the concave side of the curve on the

anterior surface, whilst the depression occurs on the side corresponding to the concavity of the curve on the posterior surface, and on the convex side on the anterior surface.

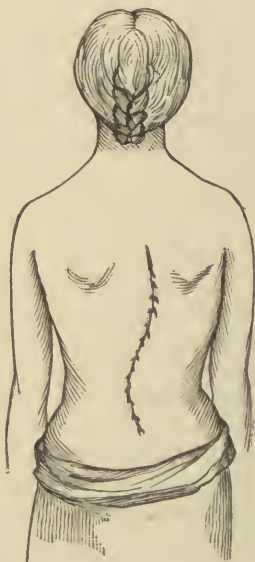
2. The external appearance presented by a case of lateral curvature in which the *lower curve is longer than the upper*, is illustrated in Fig. 754; the upper curve is to the right side and extends from the fourth to the ninth dorsal vertebra, where the left curve begins and involves the rest of the column below. The contour of the body exhibited in this case, compared with the condition present in Fig. 752, shows that increase in the length of the lower curve produces greater distortion of the lower part of the body, and that the shorter curve above gives rise to less deformity of the chest and shoulders. The flank on the right side is deepened to a very marked extent; on the left side the normal curve is almost entirely lost; in the upper part of the body the right shoulder is only slightly raised, and the right side of the chest is much less prominent. A like variation in the effects produced by the curvature will be found on the posterior and anterior surfaces: the ridge on the left side of the lumbar spine is larger and more marked, whilst the depression on the right is to the same degree increased; the positions of the right scapula and of the left breast are scarcely altered.

Fig. 754.



Lateral curvature of spine; long lower curve.

Fig. 755.



Lateral curvature of spine; equal curves

3. The conditions existing in the above cases show that deformity of the body is proportionate to the length of the curve in the spine; the longer the curve the greater is the distortion, and *vice versa*; in the third state of curvature, where the two curves are nearly equal in length, there is therefore less distortion of the trunk, because neither of the curves involves many vertebræ in its extent. In the case illustrated in Fig. 755, two curves of about the same length have been formed, the upper to the right and the lower to the left side; the right shoulder is but slightly elevated and the flanks are not seriously affected; in fact, to avoid repetition, it may be stated

that the same general condition of deformity will be found as exists in the dorsal region in Fig. 752, and in the lumbar region in Fig. 754, only to a much less degree.

The three cases which have been selected as types of the three conditions of deformity, below the fourth dorsal vertebra, all present an *upper curve to the right* and a *lower curve to the left side*, and, as has already been stated, this is the usual direction of the respective curves; such is not however a constant feature of lateral curvature of the spine, for the opposite state may occur of a dorsal curve to the left and a lumbar curve to the right side. When this latter condition of curvature is present, the distortion of the body will be correspondingly reversed, and those changes in the thoracic and abdominal regions which have been noted in the cases illustrated, will be found on the opposite sides of the body.

In the greater number of cases of lateral curvature, the deformity is confined to the lower two-thirds of the spine, but in some few instances the *upper third of the column* is also distorted. Early childhood and early adolescence have already been noticed as the periods of life at which curvature usually commences; deformity developed at the later period very rarely extends to the upper dorsal and cervical vertebræ; it is in cases which commence in early childhood that curvature in this region is occasionally met with. The structural changes in the upper part of the column, when curvature has been formed, are of precisely the same nature as those already described as occurring in the dorsal and lumbar regions; there is the same twisting of the vertebræ, with greater lateral displacement of their bodies than of the spinous processes, and the same altered relationship of the surrounding structures as a result of this displacement. The upper cervical region is never the seat of curvature except as a complication of wry-neck, with which deformity this condition will have to be considered. Idiopathic curvature may extend as high as the sixth cervical vertebra; in such a case, it is as a rule the beginning of a long upper curve extending to the lower dorsal vertebræ, from which point a second curve to the opposite side will be found involving the vertebræ below. In exceptional cases there may be a short curve above, then a second curve to the other side, and a *third curve* below, to the same side as the first; these three curves may exhibit all sorts of variations in their respective lengths. Even *four curves* may be developed, and the existence of such conditions as these has led to the grouping of cases of lateral curvature of the spine according to the number of curves found in the column; but such a classification only tends to promote confusion, and to withdraw attention from the fact that the length of the curves—the number of vertebræ consecutively distorted—is the character of deformity of chief importance.

The description that has been given of the various forms of curvature, both with regard to the structural changes in the column and the external characters presented, has reference only to that state of deformity in which the curves formed have been well marked but not of severe grade; it still remains to examine the course which the deformity follows from its first appearance to its most advanced stage.

PROGRESS OF LATERAL CURVATURE.—In the development of lateral curvature the anterior portion of the column is first deflected from the median line; the vertebræ at the seats of curvature commence to rotate, so that their bodies are turned to one side, which eventually becomes the side of convexity of the curve, whilst the spinous processes retain their normal positions. As the distortion increases, the bodies of the vertebræ become further displaced, and it is not until the curvature is well advanced that lateral deviation of the

spinous processes occurs; these parts of the vertebræ may remain in position when even an extreme degree of lateral displacement of the bodies exists. This resistance to the formation of curvature displayed by the posterior portion of the spine, is especially exhibited in the lumbar region, where the apices of the spinous processes seldom become displaced, and are never so to more than a slight degree. The evidence of existing mischief is thus not very clear in the first stage of lateral curvature: the most superficial parts of the column are not affected, and the slight deflection of the bodies of the vertebræ has not yet produced any marked effect upon the surrounding structures. In the dorsal region the curvature is usually first detected; the increasing rotation of the vertebræ, and the consequent displacement backwards of the transverse processes and ribs on the side of convexity, cause the scapula on that side to become unduly prominent, and, as the deformity advances, the shoulder to be raised above its fellow on the opposite side. At the same time the flank becomes slightly deepened on the concave side of the lumbar curve, a change which does not attract the attention of the uninitiated observer, but which should be carefully looked for in this stage of deformity. Seldom, it may perhaps be said never, is a case of lateral curvature presented to us for treatment until it has reached the condition just indicated; only too frequently the deformity is allowed to advance further, because the slight defects noticed are considered of no importance. From the state now reached, the progress of the distortion, if not checked, becomes more rapid; in a few weeks, one or other of the conditions which have been described as illustrating the three types of lateral curvature (Figs. 752, 754, and 755), is developed. Still advancing, a grave deformity is established which has the effect of seriously diminishing the cavities of the thorax and abdomen, and of thus mechanically obstructing the action of the viscera.

It is the *thorax*, the walls of which are more intimately connected with the spine than are those of the abdomen, that chiefly suffers from the distortion of the column in lateral curvature. This cavity is seriously diminished on the convex side of the dorsal curve, first by the encroachment of the bodies of the vertebræ, which are turned towards this side, and secondly by the change in the shape of the ribs. The displacement of the ribs backwards, gradually increases as the rotation of the vertebræ advances; being held in front by the sternum, which through its attachment to the clavicles prevents much lateral displacement of the anterior extremities of the bones, they are subjected to a constant strain which effects a marked change in the form of their shafts; they become as it were folded up, and shaped somewhat like the bend of a fish-hook. The thoracic cavity is thus contracted laterally, and is flattened in front, on the convexity of the curve; it is slightly increased posteriorly, but the advantage gained here is considerably diminished by the pressure of the bodies of the vertebræ. On the concave side of the curve the ribs are pushed forwards, the chest on this side being contracted behind and somewhat enlarged in front; the chief mischief on this side is found in the loss of space in the vertical direction, as the ribs are crowded together and pressed downwards, whilst their oblique direction is increased to such a degree that the last rib will often touch the crest of the ilium. This distortion of the walls of the thorax is in itself sufficient to account for the presence of impeded respiration and defective action of the heart, in cases of severe lateral curvature, but other causes of these conditions also exist: the mechanism of the costo-vertebral articulations is thrown out of gear, and the rising and falling action of the ribs is much diminished; moreover, the abdominal viscera are pressed against the diaphragm, so that in every direction is the expansion of the thoracic cavity interfered with.

The *abdominal viscera*, when the curvature is severe in the lower dorsal and lumbar parts of the spine, are much affected by the limited space in which they are inclosed. The walls of the abdomen, being flaccid, can to some extent accommodate themselves to the shortening of the spinal column in this region; the front of the abdomen becomes protuberant, but the sides are compressed by the descending ribs, especially on the convex side of the lower curve. The chief trouble that results is from compression of the liver and stomach, giving rise to sickness, constipation, and other symptoms of disordered digestion. This mechanical derangement of the abdominal and thoracic cavities renders severe lateral curvature a most formidable complaint.

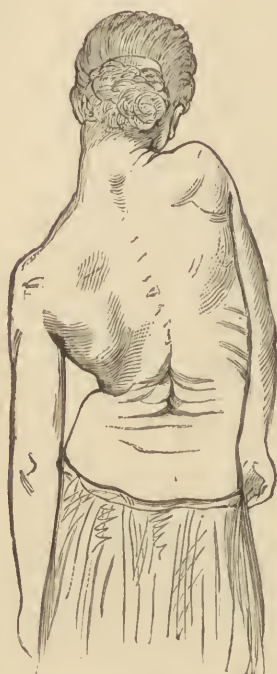
The amount of relative distortion of the chest and abdomen will depend upon the nature of the curves; the severest condition of thoracic contraction occurs when the dorsal curve commences high up in the column and extends through the whole of the dorsal region; the abdomen will be most compressed when the lower curve commences in the middle of the dorsal region and extends to the last lumbar vertebra. The former condition, of severe deformity of the thorax, is the graver complication of the two: exercise becomes almost impossible; shortness of breath, palpitation of the heart, and giddiness, all arise at the slightest attempt at exertion, and often the patient is unable to lie in the recumbent position; hæmoptysis may terminate an existence which is scarcely endurable.

DIAGNOSIS OF LATERAL CURVATURE.—The diagnosis of lateral curvature, owing to the characteristic nature of the deformity, would appear to be an easy matter; such certainly is the case if the surgeon clearly appreciates the fact that lateral curvature, much as it varies with respect to the situation and length of the curves formed, is always to be distinguished by the structural changes which occur at the seat of deformity. Unfortunately this important point is too often lost sight of, and other conditions of the spine, in which deviation of the column to one or other side is present, are confounded with true lateral curvature. To avoid this error, it should be remembered that the constant feature of true lateral distortion is greater displacement of the anterior portion of the column than of the posterior—the rotation of the vertebræ which has been so frequently alluded to. With this fact before us, an error of diagnosis is scarcely possible, except perhaps in the early stage of the affection; but before endeavoring to decide in what manner the commencement of curvature is to be detected, the spurious conditions of lateral curvature must be reviewed.

A state of lateral deviation of the spine that is very generally mistaken for lateral curvature, is met with in growing girls who live in a condition unfavorable for the healthy development of their bodies; the maid-of-all-work of the small tradesman, the drudge of the cheap lodging-house, school-girls economically received at “establishments”—all such as are overworked and miserably fed—are very commonly found to present lateral deviation of the spine when examined in the upright position. Nor is this condition peculiar to the class above quoted; the weakening effect of acute illness, disordered digestion with imperfect assimilation of food, and all those states of defective health which are so conveniently described as “general debility,” may give rise to a weakened condition of the spine in young girls of any class of life, and produce the same result. This condition is at once distinguishable from true lateral curvature, for no structural change of the spine is developed; if the subject, when under examination in the erect position, is directed to stoop forwards without bending the knees, the spine will at once lose its lateral deflection, and the same occurs when the horizontal position is assumed. There is then, in such cases, merely lateral deviation of the spine from want

of power to keep the column erect; not that such power is entirely lost, for by a slight effort the muscles may be made to bring the column straight, although

Fig. 756.



Lateral bending of spine.

relapse immediately occurs as soon as the extra muscular exertion is withdrawn. In true lateral curvature, in whatever position the subject is placed, the distortion of the spine remains, and no amount of muscular exertion will do away with the deformity. For want of a better descriptive term, this spurious state of lateral curvature may be alluded to as lateral *bending* of the spine, reserving the term *curvature* for deformity accompanied by structural changes in the column.

The external appearances of *lateral bending of the spine* are illustrated in Fig. 756, which shows an extreme degree of distortion of the body in a girl aged 18; in this case the spine and trunk became perfectly straight when the horizontal position was assumed, and the girl could straighten her spine, when in the erect position, by placing her hands on her hips and forcing up her shoulders. If this case is compared with that illustrating lateral curvature with a long upper curve (Fig. 752), a difference in the contour of the body, which at once distinguishes between the state of lateral bending and that of lateral curvature, will be observed. In the case of curvature, the raised shoulder and the deepened flank are on the same side of the body; here the right shoulder is raised and the left flank is depressed—the spine has as it were toppled over to the left.

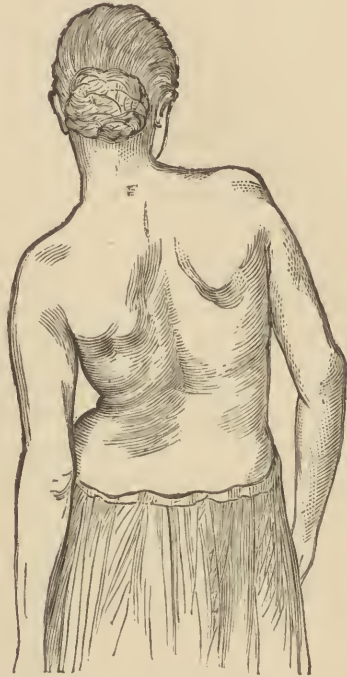
Lateral bending of the spine seldom reaches such a severe degree of deformity as was present in this patient; usually there is merely a slight bending of the spine to one side, which is readily relieved by attention to the general health; if, however, the true nature of the affection be not recognized, and if local treatment alone be adopted, as in the case of this girl, the deformity will continue to increase.

That a case of *Pott's disease of the spine* should be mistaken for one of lateral curvature, would appear hardly possible, yet such an error has come under my notice on more than one occasion. When caries chiefly affects one side of the bodies of the vertebræ, the column gives way towards the side of greatest destruction, and a decided condition of lateral deflection becomes established. There is in these cases a feature which should prevent any error in diagnosis; the spinous processes are always unduly prominent, and the condition of angular deformity coexisting with the lateral displacement marks clearly the real nature of the case. Lateral deflection of the spine may, however, be the first symptom of commencing mischief in the early stage of Pott's disease, before destruction of bone has occurred; in such a case the affection may very excusably be supposed to be merely lateral bending of the spine. Fig. 757 illustrates an example of this condition. The subject was a girl aged 19, who was in a weak state of health and had been working as a general servant; the external appearances of the trunk presented a very similar state of deformity to that exhibited in the case of lateral bending shown in Fig. 756. The deformity entirely disappeared when she was placed in the recumbent position, and also when stooping, and a careful

examination could detect no abnormality of the spinal column, either with respect to its mobility or to the position of the vertebræ. The case was accepted as one of weak spine with lateral bending, and was treated accordingly. Having been a few weeks under treatment, she complained of pain at the seat of the second lumbar vertebra, and there was then found to be some rigidity of the spine at this spot; recumbency was ordered, and all other form of treatment withdrawn; at this time the photograph from which the accompanying illustration is copied was taken; in the wood-cut, the letter *A* marks the situation of decreased mobility and pain. In three weeks' time there was slight prominence of the spinous processes of the second and third lumbar vertebræ, and the case was clearly demonstrated to be one of Pott's disease of the spine. The chief interest attached to this case belongs rather to the diagnosis of the early stage of caries of the vertebræ, than to that of lateral curvature; but it is nevertheless instructive as showing the difficulty which occasionally attends recognition of the true nature of an affection of the spine accompanied by lateral deviation of the column.

It has already been remarked that, in the diagnosis of lateral curvature, some difficulty may be experienced in detecting the early stage of the deformity; as it is of course of the highest importance that the commencement of curvature should be recognized, it is necessary to be acquainted with the possible sources of error that exist. It is by no means uncommon for lateral bending of the spine, occurring to a slight degree, to be mistaken for lateral curvature, and also for the latter to be regarded as mere lateral deviation of the column from weakness; such want of discrimination has been frequently brought under my observation, either in hospital practice or in the examination of patients applying for surgical appliances to one of the London charities. In the early stage of both affections, there is no deviation of the spinous processes when the patient is lying down or bending forwards, and it may be here remarked that no just conclusion can be arrived at if the subject is only examined when erect. The history of the case is to some extent a guide to the surgeon; in lateral bending of the spine, there is always to be traced some cause of bodily weakness such as was described when considering the nature of that affection, but lateral curvature may be and indeed generally is preceded by no conditions that have produced debility. Again, the attitude of the patient when standing is worthy of notice; in the atonic lateral deviation of the column, the subject stands in a weary, drooping manner, the head is bent forwards, and the arms hang listlessly by the sides; in lateral curvature, on the contrary, the arms are usually kept erect, and tend rather to brace up the muscles of the back and give rigidity to the trunk. In both conditions of the spine there may be present some slight difference with regard to the scapulæ, the bone on one side being a little more prominent and rather higher than its fellow; the shoulders, too, may be somewhat

Fig. 757.



Lateral deflection of spine in early stage
of Pott's disease.

uneven, the one being raised rather above the level of the other. In the case of lateral curvature, these differences, when existing, will be persistent in spite of the efforts of the surgeon to correct them: if the depressed shoulder be pushed up, it will directly resume its former position on being released, and the prominence of the scapula will not be corrected except by altering the position of the arm; in lateral deflection, however, these malpositions can be corrected by the efforts of the patient herself, and by muscular action.

Having observed the conditions presented when the subject is in the erect position—standing, that is, with the feet together, the legs straight, and the arms by the sides—the spine must next be examined when bent forwards. The patient should be directed to stoop, bringing the shoulders about on a level with the pelvis, without bending her knees; the surgeon then, with the fore-finger of each hand, carefully feels along each side of the spinous processes from the first dorsal to the last lumbar vertebra, in order to ascertain if in any part of the column there is a greater fulness on one side than on the other. The slightest deflection of the bodies of the vertebræ to one side will be at once detected by this examination: on the side towards which rotation has commenced, the transverse processes will be turned a little backwards; on the opposite side they will be directed forwards; digital pressure will reveal a slight fulness in the former and a corresponding depression in the latter situation, at the seat of commencing curvature; but when no rotation is present, the furrows on each side of the spinous process will be exactly similar, and that the case is merely one of lateral bending of the spine may be confidently declared.

The differences between lateral curvature and lateral bending of the spine are clearly such as should prevent any difficulty in recognizing the respective

conditions of deformity, but it occasionally happens that the two are found combined in the same person, when it becomes necessary to distinguish to what degree the distortion depends upon structural change, and what share in the case is to be ascribed to spinal weakness. Such a case is illustrated in Fig. 758, taken from a young girl aged seventeen, who, for about two years before the condition here represented had been reached, had suffered from deformity of the spine. The external appearances exhibited here, show much the same nature of deformity as do the case of commencing Pott's disease (Fig. 757) and that of lateral bending (Fig. 756); if the three cases are compared, they might very naturally be supposed to represent three stages of the same condition of distortion, yet each is an example of a different state of lateral deviation of the spinal column. The patient here referred to had been treated for some length of time for lateral curvature, but the method employed was unsuitable for her condition, and lateral bending of the spine was developed in addition to the curvature; the reasons for this unfortunate result will have to be referred to when the question of treatment is under consideration; for the present, we are concerned only with the existing complication of two conditions of distortion. This two-fold displacement of the column is also met with in

Fig. 758.



Combined lateral curvature and bending.

subjects who are afflicted with lateral curvature, the development of which is accompanied by debility, or who, being already afflicted with curvature, are exposed to causes which induce a weak state of health, and give rise to lateral bending of the spine in addition to the previously existing structural deformity. The analysis of such cases is quite simple: we have only to note the condition of the spine and trunk when the patient is standing up, and then to observe the effect produced by causing her to stoop forwards; the differences of deformity existing in these two attitudes will be the amount depending upon lateral bending, the permanent state of distortion when the spine is bent being alone due to lateral curvature. In the case shown in Fig. 758, there was marked rotation of the vertebræ to the right side from the third to the eleventh dorsal, and the same condition towards the left side from the twelfth dorsal to the last lumbar.

ETIOLOGY OF LATERAL CURVATURE OF THE SPINE.—The great diversity of opinion that exists upon the subject of the causation of lateral curvature, has already been alluded to, and it has been noted that this want of concord has been ascribed to the fact that in the investigation of this question the surgeon, being unable to obtain for necroscopic examination a spine in the early stage of deformity, is compelled to a great extent to base his theories upon speculation. It is, however, probable that were this difficulty removed, post-mortem examination might lead to no satisfactory results, for the changes which occur in the spine and surrounding structures are essentially such as belong to vital action, and even the microscope might fail to detect changes which nevertheless, during life, seriously influenced the functional properties of the affected tissues. It is scarcely necessary to point out that, in spite of all the appliances for skilled investigation with which science can supply us, changes do occur in living tissues which, although sufficient to destroy vitality, are yet undemonstrable after death. Of the many theories that have been advanced as to the etiology of lateral curvature, it is difficult to select one that satisfactorily accounts for the development of the deformity; most careful investigation is still required of this subject, and our efforts must be directed to determine whether the distortion is consequent upon changes in the column itself, which render it unfit to fulfil its physiological functions as a supporting column, or whether the curvature results from external influences which act upon the spine and disturb its adjustment, or, again, whether it is a combination of these processes which gives rise to the deformity.

The development of lateral curvature is by recent authors usually ascribed to the action of causes which are not of innate, but of external, origin; by earlier writers the curvature was considered to be dependent upon changes in the bones, variously described as of an inflammatory, rachitic, or scrofulous nature; a better knowledge of the morbid anatomy of this deformity, together with the production of evidence of the fact that curvature often exists in a spine the bones of which are in no way affected beyond being displaced from their normal positions, disproves the truth of these early theories. When referring to the history of orthopædic surgery, it was remarked that the scientific treatment of deformities had been developed from the introduction of subcutaneous tenotomy, which had been first successfully employed in the treatment of club-foot. The fact that the latter distortion was directly dependent upon muscular contraction, led investigators to conclude that other deformities of the body probably arose from the same cause; this no doubt influenced their judgment, and suggested the theory that lateral curvature, not being due to disease of the bones of the spine, was necessarily of external origin, and that of all forces acting upon the spine,

none was so likely to produce displacement of the column as that of abnormal muscular contraction.

Various theories have been advanced in regard to the method by which the symmetry of the spine is destroyed by the action of the muscles of the trunk. Spasmodic muscular contraction must be noticed as one of the ascribed causes of lateral curvature, but upon this theory it is not necessary to dwell at any length; spasmodic contraction of the muscles of the trunk is very seldom met with, and when such does occur, the muscles are generally affected alike on both sides, so that the body is drawn directly backwards and not laterally. Further, it may be remarked that nerve-irritation and muscular spasm are essentially affections of early childhood, whilst lateral curvature is in the large majority of cases developed at a later period of life. The influence of muscular action in the causation of lateral curvature, has been more generally regarded, not as the first, but as the exciting cause of deformity; as predisposing causes are given, debility—the result of exhausting disease such as scarlet fever—weakness from rapid growth, over-exertion of the bodily strength, irregularity of the menstrual function, the non-observance of proper hygienic rules, and other like conditions which induce a feeble state of health. Such depression of the bodily powers may or may not precede the formation of lateral curvature, but if pre-existing, how the muscles thereupon become the instruments which promote distortion of the spine, is not very clear; this is shown by the want of agreement amongst authorities who are of one opinion in ascribing the formation of curvature to muscular action, but who differ very much as to the precise manner in which that influence acts upon the spine.

The theory of excited muscular action which obtains the most support, is explained by pointing to the practice which is common amongst young girls, especially those who are not very robust, of adopting bad habits of position, such as standing on one leg and sitting awry, whereby the pelvis is tilted and the spine kept in a condition of curvature. By thus habitually bending the spine in one direction, it is assumed that, on the side towards which the column is inclined, the muscles become shortened, and that contraction of their fibres results, establishing a confirmed condition of deformity. It is well-known that, in the treatment of a fractured limb, if a joint be fixed in the flexed position for a lengthened period, it will become contracted from shortening of the flexor muscles; but we know also that if the joint be moved even once a day to the full amount of its proper extension, such contraction will be prevented. In the case of the spine, even if there be this habit of constantly tilting the pelvis, it must be allowed that frequent changes in the position of the body are assumed, and that the muscles are sufficiently often relaxed to prevent them from becoming permanently shortened; moreover, during sleep the muscles are rested, for although it was formerly argued that by lying on a feather bed the pelvis was kept uneven at night, in these days feather beds are seldom used, and the firmer couch now universally adopted keeps the spine in good position. There is a class of subjects, in whom, when standing, the pelvis is always tilted—those who from some cause suffer from shortening of one lower extremity; such subjects are declared by many authors to be especially liable to acquire lateral curvature. My own experience is quite opposed to such a statement; among the many applicants to the Surgical Aid Society of London, investigation has failed to discover the complication of lateral curvature in those who apply for instruments to remedy the shortening of a limb; this is the more noteworthy because the greater number of these cases are of the very poorest class, suffering from lameness due to disease of the hip-joint, to excision of the knee, to paralysis of one limb, and to various causes which clearly indicate a defective condition of health. If

further consideration is necessary before dismissing the theory of acquired muscular contraction, I would refer again to the case illustrated in Fig. 756, described under the subject of lateral bending of the spine; surely if muscular contraction consequent upon assuming a bad position were the cause of lateral curvature, such a case as this ought to have developed the deformity; yet the spine remained unaffected by structural change, although the distortion had existed for two years.

The formation of curvature by muscular action has also been ascribed to the existence of greater power of the muscles on one side of the body; thus, in the dorsal region of the spine, it has been reasoned that the right lung is more capacious than the left, that the right arm exceeds the left in weight, and that therefore the muscles passing between the spine and the chest and arm, are stronger on the right than on the left side, and that by their action the spine is dragged into a condition of curvature. The serratus magnus muscle is regarded as the principal agent in producing the deformity; by its action upon the ribs it converts these bones into levers, and twists around the neighboring vertebræ. The objection to this theory is that lateral curvature of the spine should, according to this reasoning, be a frequent complication of chronic affections of the lungs, when one lung is more affected than the other; but this is not the case, for the victims of phthisis are very rarely the subjects of lateral curvature; moreover, it is difficult to understand how the serratus magnus muscle could act in the manner described, since it is, through the scapula, directly dependent upon the spine itself for its fixed point for action. One more argument in favor of the muscular origin of curvature may be noticed before leaving the subject; the probability of the muscles of the trunk being chiefly instrumental in developing abnormal curvatures of the spine, has been supported by ascribing to the same influence the formation of the normal antero-posterior curves. The spine of the infant, we are told, is shaped after this manner: the psoas muscles draw forwards the lower vertebræ, the erectores spinæ pull back the column above this point, still higher the vertebræ are again brought forwards by the abdominal muscles, and the normal shape of the spine is completed by those muscles which are attached to the occiput producing by their contraction another curve. Supposing that we accept this hypothetical explanation of the formation of the three normal antero-posterior curves of the column, to what guiding influence are we to attribute this exact modelling by contraction of the various muscles? and having solved this problem, how are we to apply our knowledge so as to arrive at the influence which gives origin to abnormal curvatures? It can scarcely be doubted that, had the muscular-causation theory of the development of lateral curvature never been advanced, the formation of the normal curves of the spine by muscular action would not have been suggested.

The theory of causation which we have next to consider, differs in a most important respect from those already passed in review, for the formation of curvature is ascribed to changes arising within the column itself, these changes being due to certain predisposing conditions. The first predisposing cause is the existence of considerable flexibility of the spine at the age at which curvature is developed; this normal flexibility is unduly increased in young girls by deterioration of the muscular tissue which results from their pursuing a sedentary mode of life, precluding the healthy development of the muscles of the back; as a sequence of this muscular weakness, sympathetic degeneration of the ligamentous tissue ensues. Deprived thus in a great measure of the support which it receives from the muscles and ligaments, the spine is chiefly dependent upon the articular processes for power to resist pressure applied in a lateral direction. If then the subject, with a spine thus weakened, frequently throws the column into a condition

of curvature, by standing or sitting in attitudes which tilt the pelvis, structural changes in the spine will occur from absorption of the articular processes, these bony projections being imperfectly formed in youth, and quite unable to resist lateral pressure constantly directed against them. Following this line of argument still further, the conclusion which must be reached is that the amount of structural change within the column will be greatest where the articular processes, from their shape and direction, offer the least resistance to the exciting cause of deformity, because in that region of the spine the obstacles to rotation of the vertebræ will be the more easily overcome; again, in that part of the column where the articular processes are best designed to give lateral support, there rotation will be the least developed, in consequence of the better defence opposed to the destructive pressure. In truth, we find the very reverse of these conditions in practice: in the lumbar region of the spine, the vertebræ are especially protected by the shape of their articular processes against lateral pressure, yet in this situation are to be found the most extreme examples of structural change within the spine without lateral deviation of the whole column; in the dorsal region, the deflection of the bodies of the vertebræ seldom proceeds far before the displacement of the spinous processes takes place, although the resistance offered by the articulating processes to lateral pressure in this region is much less than that presented by the corresponding structures of the lumbar vertebræ.

The various theories most deserving of notice, as being those upheld by authorities of the present day, upon the causation of lateral curvature of the spine, have now been discussed, but the subject has by no means been thoroughly exhausted; the space at my command will not admit of a full analysis of the many speculations that have been put forward, each as the true explanation of the development of this deformity—speculations varying from the simple suggestion that the habit of wearing stays is the origin of the affection, to the more complex theories supported by diagrammatic illustrations and mathematical formulæ. To follow the course of the development of lateral curvature from the first departure from the normal condition to an advanced state of deformity, is a method of investigation which is denied to us; such a progressive examination of the morbid changes in the spine through the various stages of this affection, could by no possibility be the work of one inquirer, unless supported by means of research which no individual is likely to be able to command. In attempting to solve the problem as to the causes on which the formation of lateral curvature depends, we can only rely on our knowledge of the physiological properties of the healthy spine, the nature of the anatomical changes which occur in the deformed column, and the clinical facts which accompany the development of these changes.

With regard to the physiological properties of the spine, we are concerned chiefly with the functions which it fulfils as a supporting column and as the foundation of the skeleton; with its property as a protecting canal which contains the spinal cord, we are not interested. The bodies of the vertebræ and the intervertebral disks form the supporting section of the spinal column, and, as we have seen, these are the parts of the spine which are chiefly displaced in lateral curvature. The structure of the anterior portion of the spine is so designed as to enable the column to bear a considerable weight, and at the same time to permit of the necessary movements of the trunk; composed of alternate layers of light cancellous bone and elastic fibrous tissue, united together by various ligaments, it presents a column consisting of a series of curves and pyramids, and possessing the three attributes of strength, flexibility, and elasticity. The quality of flexibility is not equally distributed throughout the spine: the cervical region possesses the

freest powers of movement both in the antero-posterior and lateral directions; in the dorsal and lumbar regions, the range of motion from before backwards is about equal; but in the latter region lateral movement is more limited than in the former. The variation in the amount of movement of which the separate regions of the spine are capable, depends upon differences in the shape and direction of the articular processes, and upon the thickness of the intervertebral disks. The free movements of the cervical vertebæ are gained by the articular processes being so shaped as to permit of a good deal of motion between the bones, apart from that given by the soft intervertebral disks; in the dorsal region, the movement is derived about equally from the intervertebral disks and from the play between the surfaces of the joints on the articular processes; in the lumbar region, the intervertebral disks afford the greatest freedom of movement, the lateral motion being entirely gained from these structures. The property of elasticity possessed by the spine lies wholly within the intervertebral bodies; the structures, on being compressed, have the power of self-expansion, a power that the tissue of which they are composed is not capable of exercising immediately, but which it requires some little time to exert, so as to restore the disks to their full size; the longer the compressing force is applied to these bodies, the slower will be their return to their proper thickness. The loss of length which occurs in the spine of an adult who has been for some hours in the erect position, is due to compression of the intervertebral bodies, the loss amounting to about one inch; after some few hours in the recumbent position this loss is regained by the gradual expansion of the fibrous tissue, so that as the total thickness of all the intervertebral bodies is rather less than four inches, the elasticity of these structures is able to overcome the effect of a pressure which reduces them more than one-fourth of their proper size.

The nature of the anatomical changes which occur in lateral curvature of the spine has already been fully described, but attention may again be called to the fact that in the early stages of the deformity the structural defects in the column are limited to the intervertebral disks and ligaments, and that the bones are not altered in shape until the curvature is in an advanced condition.

The clinical characteristics of lateral curvature may be summarized as follows:—

- (1) It commences at one of two periods of life, early childhood or early adolescence.
- (2) It affects girls much more frequently than boys.
- (3) It is not of traumatic origin, nor is its onset accompanied by any local symptoms which indicate the presence of active morbid changes in the structures of the vertebral column.
- (4) It may be associated with debility and with muscular weakness, but it not unfrequently occurs in subjects who are robust and strong.
- (5) It is often combined with defective menstruation when commencing at the age of puberty.
- (6) It prevails in certain families, and is often hereditary.

In reviewing the various theories which ascribe the development of lateral curvature to the influence of external agents, such as muscular action, an attempt has been made to point out in what respects these theories fail to satisfactorily account for the origin of the deformity; so also objection has been made to the explanation which refers to absorption of the articular processes the formation of confirmed curvature. In attempting to solve the important problem of the etiology of lateral curvature, attention must be especially directed to the fact that mere constant bending of the spine to one side will not induce a condition of structural change; so that there must exist,

also, within the column itself, some contributory defect without which lateral curvature will not become developed. As to the particular nature of the defective condition of the column which conduces to the development of lateral curvature, it is impossible to give a decided opinion, but in all probability the ligaments and intervertebral disks are the seats of mischief.

For the sake of definition, let it be taken for granted that these structures are wanting in their normal qualities; the spine would then be affected in two of its principal properties, viz., flexibility and elasticity. The flexibility of the spine is chiefly restricted by the ligaments which connect together the several vertebræ; if these ligaments have lost their normal tenacity, the flexibility of the spine must be increased; again, the column derives its elasticity from the intervertebral disks, and if the tissue of these structures is degenerated the power of elasticity will be lessened. A spine thus unduly flexible and deficiently elastic, will be in just the condition to develop lateral curvature, if the subject is in the habit of standing and sitting in such positions as tilt the pelvis and throw the column into a state of curvature; because the weakness of the ligaments will readily permit of the bending of the column, while the intervertebral cartilages, from their want of elasticity, will be unable to recover from the unequal compression to which they are subjected; thus day by day a gradual deflection of the column will take place, and a state of curvature will become established.

I am not in a position to prove absolutely the theory above offered, that degeneration of the fibrous tissues of the spinal column is the original source from which lateral curvature is developed; the only evidence which could definitively establish this proposition as a pathological fact, would be the demonstration that the ligaments and intervertebral disks in the early stages of lateral curvature, differed in certain structural respects from the same tissues in the healthy column. But the difficulty of making this demonstration is very great; in the first place, it is seldom that an observer has the opportunity of making a post-mortem examination of a spine in the early stage of the deformity, and even when this chance is presented, it is with dead tissues only that he can experiment, rendering the worth of the experiments of very doubtful value; it must be taken into account, too, that the qualities of the tissues, the impairment of which has to be proved, may very well have degenerated without there being any clear indication of structural changes. There is, however, some valuable circumstantial evidence which may be advanced in favor of the above theory; thus, at the periods of life at which lateral curvature commences, the deformities knock-knee and flat-foot are very commonly developed, and indeed these two distortions and lateral curvature may be said to comprise ninety-nine out of every hundred cases of deformity commencing between the ages of ten and twelve years. Now knock-knee and flat-foot, in the great majority of cases, admittedly result from ligamentous weakness, arising respectively from insufficient resisting power of the internal lateral ligament of the knee-joint, and from weakness of the ligaments of the sole of the foot; defect of the fibrous tissues being thus the producing cause of two out of three of these deformities, we may justly conclude that the third is likely to be due to a similar defect, it further being considered that lateral curvature and flat-foot are frequently found to exist in the same subject. Moreover, that loss of elasticity and increase of flexibility in the spine give rise to lateral curvature, would, if admitted, account for the somewhat irregular manner in which this deformity selects its victims; it has been shown that subjects who would seem to possess all the qualifications necessary for the development of lateral curvature, such, for instance, as the patient whose case is illustrated in Fig. 756, nevertheless escape the distortion; whilst strong, healthy girls, with good muscular organization, and apparently well

able to resist the effects of any amount of strain that may be put upon their spinal columns, yet become seriously deformed. In the first case, although the column is constantly kept in a state of curvature during the daytime, the flexibility and elasticity of the spine are such that it recovers during rest, and does not become permanently altered in shape; in the second case, although only subjected to the normal amount of bending, it is, from defective condition of its most important qualities as a weight-bearing column, unable to regain its natural shape, and thus gradually becomes permanently curved.

The cause of the peculiar method of displacement which characterizes lateral curvature, the so-called rotation of the vertebræ, is probably due to the anatomical construction of the spine. The anterior portion of the column—the bodies of the vertebræ—is not provided with much lateral support; whilst its posterior portion—the arches of the vertebræ—is stayed up by numerous muscles and bands of fascia. The anterior portion, being that part of the spine which fulfils the duty of a weight-bearing column, is also especially liable to be affected by the exciting causes of lateral curvature; it is moreover largely constructed of fibrous tissue, and it is not therefore surprising that it should first be deflected from the median line. The varying extent to which rotation occurs in the different parts of the column, is also to be explained by the construction of the intervertebral bodies: it has already been noticed that excess of displacement of the anterior portion of the column over the posterior, is much more marked in the lumbar region than in the dorsal; in the former situation, the relative thickness of the intervertebral disks is much greater, whence the tendency to rotation; also the lateral support which the posterior parts of the lumbar vertebræ derive from the muscles and fasciæ, tends to contribute to their stability. The term rotation of the vertebræ does not accurately define the real nature of the distortion, which consists really of a general twisting of the column at the seat of curvature, and not of rotation of the individual vertebræ upon their axes.

TREATMENT OF LATERAL CURVATURE.—The various methods which have been employed to restore the scoliosed spine to its normal shape, may be classified in two divisions—the physiological and the mechanical. The former of these consists chiefly in the use of different exercises, so designed as to bring into action the muscles of the trunk on the concave side of the curve, and thus to draw the spine towards the mesial line; a mode of treatment which is adopted by those who consider that irregular muscular action is the producing cause of the deformity. Mechanical treatment has been applied in many ways, all of which are modifications of one of two different plans for bringing mechanical force to act upon the column in order to reduce the deformity. Of these two mechanical methods, one consists in the application of pressure whilst the subject is in the horizontal position, a couch with adjustable levers and movable pads being the instrument usually employed; the other method requires the use of an appliance fixed to the body, and so constructed as to admit of pressure being brought to bear upon the spine at the seats of curvature. The above measures of treatment have each their separate advocates, each plan has received enthusiastic support as well as severe condemnation, and here again the want of unanimity may be ascribed to an absence of agreement amongst authorities upon what does and what does not constitute lateral curvature; thus, it is not uncommon to find a case of lateral bending of the spine, which has been successfully relieved by a certain mode of treatment, described as one of lateral curvature—a mistake which is naturally productive of confusion in any discussion which may ensue as to the value of the measures of treatment employed. In endeavoring to decide upon the best plan to adopt for the reduction of lateral devi-

ation of the spinal column, it is of the first importance that the varying conditions of deflection should be clearly distinguished one from another; that condition which has been described in this article as *lateral curvature* being the most grave condition of deformity, its treatment may well claim priority of consideration.

The opinion is very generally held that all attempts to reduce the distortion in a scoliosed spine are pretty sure to be attended by failure; undoubtedly, when the distortion has existed for some years and has reached a severe grade of deformity, the restoration of the spine to its normal condition is not possible by any methods of treatment with which we are at present acquainted; it is also true that this advanced stage of deformity is very commonly met with, so that at first sight it might appear as though the relief of lateral curvature was in all its stages not attainable. There are many causes, however, which contribute to the development of lateral curvature, and to its advance to an incurable stage—causes which are beyond the control of the surgeon; the chief of these is the neglect often exhibited by the patient or her parents, to seek advice whilst the deformity is yet in its early stage. Unattended by any general failing of the health, as is so frequently the case, the first evidences of commencing curvature are disregarded; and the prominent shoulder, or hollow flank, is looked upon as merely one of those bodily defects which will disappear with advancing age, and that mysterious power which consists in “growing out” of the defects, is trusted to put all straight with time. Even if the above mistake is avoided, and advice is sought for at the right time, it is not uncommon to find those who are especially interested in the well-doing of the patient, quite incapable of appreciating the absolute necessity which exists for carefully following out the methods of treatment which are ordered; they fail to understand that so apparently slight a condition of bodily change may lead to a state of most sad deformity, and the instructions for the management of the case are so simple in their nature that they lack that attribute of impressiveness which is so necessary to the uneducated mind. In the treatment of lateral curvature, the means selected must vary according to the nature and condition of the displacement; with reference to this point, authorities usually describe the deformity as passing through three stages, a first stage of incipient or commencing curvature, a second stage of established curvature, and a third stage of confirmed or incurable curvature. The distinction between the first and second stages is often made by defining the latter as that period at which rotation of the vertebræ occurs; this is an error which has arisen from an inability to distinguish between the different forms of lateral deflection, the so-called first stage of lateral curvature being in fact merely lateral bending of the spine, for, as has already been described in this article, lateral curvature from its first commencement is accompanied by rotation of the vertebræ, the displacement of the bodies of the vertebræ always preceding the deviation of the spinous processes. The stage of curvature is by no means the chief point which is to be considered; of far more importance are the nature and position of the curves formed in the spine, with reference to which the nature of the treatment must be adapted to meet the peculiarities of each particular case.

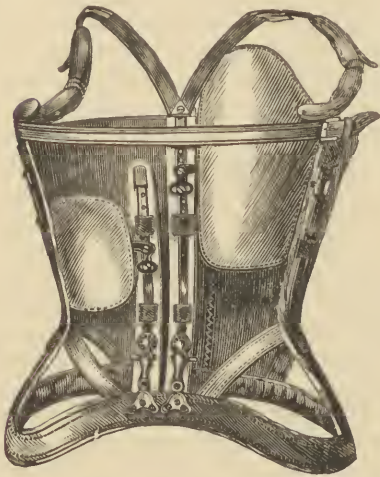
With regard to the commencing stage of lateral curvature, there are certain general rules which are applicable to all cases. The departure from the normal condition of the spine which has to be dealt with at this period, consists in the deviation to one or other side of the bodies of a certain number of the vertebræ: if the dorsal region be affected, there will be some prominence of the scapula on the side to which the bodies are turned, with perhaps a little elevation of the shoulder; in the lumbar region, there will be slight fulness

of the muscles on one side of the spine, with a depression at the corresponding spot on the other side; and together with these external evidences of curvature, there will be compression of the intervertebral disks on the concave sides of the curves. There may be present with the local defect some interference with the general health, the most frequent fault being irregularity of the menstrual function; when this or any other form of malady exists, it must of course receive attention. As to the condition of the spine, the chief points to be gained are restoration of the normal state of the intervertebral disks and replacement to the straight line of the bodies of the vertebræ; to meet these indications, the following course of treatment is generally applicable. The spine should be douched daily with cold water, and afterwards be well rubbed with a rough towel, and shampooed for about ten minutes with the hand; local circulation is thus stimulated, and nutrition is promoted. Standing about, or sitting on a stool or chair with a straight back, should be strictly prohibited (in either of these positions, leaning to one side or the other is certain to occur), and a chair with the back sloping to about half a right angle with the seat should always be used. All employments or games in which one arm is used more than the other must be interdicted, but a moderate indulgence in such pursuits as equally give exercise to the two sides of the body is to be recommended; rowing, or rather sculling, is an excellent although perhaps somewhat manish exercise, and swimming also is beneficial. Walking is the most desirable of all exercises, but nothing must be done which produces fatigue, and the recumbent position should always be assumed for about an hour after exercise. Such accomplishments as piano-playing need not be altogether given up, but these practices must be followed early in the morning when the spine has been strengthened by the night's rest. In this early stage of deformity, it is generally considered that mechanical support of the spine is not required, but as to this point no universal rule should be followed: when the curves present are not of any great length, a mechanical appliance is not necessary, but when several consecutive vertebræ are displaced, it is advisable to order a light corset stiffened with small steel bands, which gives some support to the spine and limits lateral movement of the column. The general directions given thus far are intended to fulfil the following purposes: to permit of sufficient use of the spine to keep it in healthy action; to check unequal compression of the intervertebral bodies; and lastly to allow those bodies which are deficiently elastic the opportunity of gradually recovering their normal state of expansion. The commencing stage of lateral curvature is not unfrequently treated by complete recumbency; no doubt, constant lying on the back relieves the intervertebral disks from all risk of compression, but I believe that a limited use of any part, which is not affected with inflammatory action but merely in a condition of atonic degeneration, is most beneficial to the disordered tissues. It is sufficiently familiar to all surgeons that disuse is accompanied by wasting; to leave the intervertebral disks in a state of sluggish repose, is not calculated to induce the restoration of their natural elasticity. A contrary method of treatment is the employment of free extension of the spine, either by causing the subject to swing on a trapeze, or by some other method of suspension: this procedure is unadvisable, as it produces too great stretching of the fibrous tissue; and it is not better contrived to restore the elasticity of the intervertebral bodies, than would be constant expansion to renew that of a weakened spring.

When lateral curvature is not arrested by the above measures, or when it is presented for treatment in a more advanced condition than that just considered, it is necessary to employ some form of mechanical treatment. The most convenient method of using instrumental treatment is by means of an appliance fixed to the body, which shall exert a constant pressure upon the

displaced vertebræ, and prevent them from becoming more removed from the mesial line. Very many different kinds of spinal support have been invented for this purpose, but to describe these would occupy too much space, and I shall only allude to those which practical experience has shown to be efficient in obtaining the desired result. The qualities required in a spinal support are the maximum of strength with the minimum of weight; rigidity is of all things essential, and the difficulty is to obtain this without making the instrument so heavy that it is an incumbrance rather than a support to the patient. It is also necessary that the appliance should be so adjusted as to produce pressure at the seats of curvature, and be capable of readjustment as the deformity becomes lessened. A spinal instrument which shall fulfil the above conditions must consist of two portions—one a rigid frame-

Fig. 759.



Spinal support with levers and plates.

work which can be firmly attached to the body, and the other of movable parts to exert pressure upon the displaced vertebræ. The instrument illustrated in Fig. 759 is commonly called the lever support, and is the best form of appliance to use when the surgeon is able to see the patient frequently. The framework of this support consists of a pelvic band which is so curved that it fits accurately to the pelvis (a point which is of great importance), and to which are attached on each side lateral supports terminating in crutches; steel bands, passing over the hips, connect the belt and lateral bars, which they hold firmly together, thus giving rigidity, and at the same time permitting very light steel to be used in their manufacture. A light thoracic and abdominal belt, which laces down the front, completes the framework of the support. The acting part of the instrument consists of levers, to which are attached plates which are carefully fitted to the curved portions of the spine, and which are at the same time made sufficiently large to give lateral support to the body. In the condition of curvature usually met with, that of a dorsal curve to the right side and a lumbar curve to the left, the upper plate is attached to the right side and made long enough to extend over the whole length of the curve, and broad enough to cover the posterior surfaces of the corresponding ribs; the lower plate is fixed to the left lever, and is so fitted as to press upon the displaced lumbar vertebræ. The levers to which the plates are attached are supplied with rack and pinion movements, by which the plates can be moved in a forward direction, or laterally, as may be required. In using the lever instrument, care must be taken not to exert too much force, but merely to make firm pressure with the plates upon the displaced vertebræ; a common error in fitting this appliance consists in making the side crutches too long, for the purpose of pushing up the shoulders and thus endeavoring to produce extension of the spine. Of course, no amount of elevation of the shoulders will have any effect upon the spinal column, and the only use of the crutches is to afford lateral support to the instrument, and to give counter-resistance in front to the pressure of the lever plates.

Spinal couches, which have been already referred to as one form of the mechanical appliances used in the treatment of lateral curvature, are not

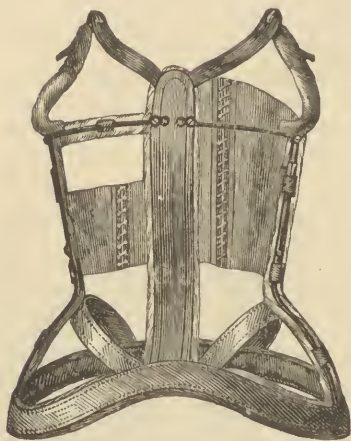
much employed in the present day. The principle upon which they act is by no means a bad one, and in a few cases I have employed a method of somewhat the same nature, and with some measure of success. The patient lies in the prone position upon a firm mattress; the pelvis is fixed by a belt which is itself attached by means of cords to rings fitted to the floor, or to heavy weights, so as to steady the body. The arms are fully extended, and a rod is grasped with the hands in such a manner that the patient can exercise a slight amount of self-extension of the spinal column. Upon the seats of curvature, bags of shot are laid along the sides of convexity, the weight being regulated by the feelings of the patient, and just such an amount of shot being used as can be borne with perfect comfort. By this method the vertebræ are pressed forward into position whilst the spine is slightly extended, and thus in a simple manner is obtained the action of the cumbersome spinal couch with its formidable-looking levers and extension-racks.

The most effectual method of acting upon the displaced vertebræ is by manipulation; this treatment, employed many years ago, has been almost entirely discontinued, yet to its use we are indebted for the first discovery of the fact that lateral curvature of the spine is something more than a mere lateral deflection of the column, for Dr. Dodds, in using manipulation, found that the vertebræ were twisted as well as displaced to one side. The use of manipulation, and the advantage thereby gained in the treatment of various other conditions of distortion, have been frequently described in this article; and the same agent, in my opinion, is of equal value in the treatment of lateral curvature, for no mechanical appliance can act with the same precision, and give such well-directed pressure, as the hand. The patient may lie in the same position as that described for the employment of weights during slight extension; instead of acting upon the displaced vertebræ with bags of shot, an attendant steadily presses with the hand upon the convex side of the curve. The upper and the lower curves are worked at simultaneously, a hand being placed on each, commencing at the lowest vertebra and gradually going upwards through the curves, and continuing the exercise for about half an hour. The employment of manipulation, with the application of the lever spinal support, and the observance of the general rules laid down for the treatment of the early stage of curvature, constitute the most efficient plan to adopt for the relief of curvature existing in the conditions illustrated in Figs. 752, 754, and 755; modifications in the treatment are required according to the seat and length of the curves. When there is either a long upper or a long lower curve, the precautions as to rest, etc., must be most strictly adhered to, for the greater the number of vertebræ consecutively involved in a curve, the greater is the risk of increase of the deformity, and the more necessity there is for relieving the spine from unequal compression.

In the more advanced conditions of lateral curvature, reduction of the deformity can never be completely obtained, but usually a considerable amount of improvement can be effected by the use of mechanical appliances. The most suitable instrument to be used in such cases is that illustrated in Fig. 760; this support consists of a framework somewhat similar to that of the lever instrument already described, the pubic belt and arm-crutches, with the hip-pieces, being the same in each appliance. Instead of the movable levers, a central bar of steel is carried up the back, being connected to the arm-crutches by two bands of steel passing across the scapulæ. The acting portion of the appliance is found in two shields of strong jean, which can be tightened by means of a lace; these shields are attached to the side crutches and the central bar, and can be made to produce any degree of pressure upon the thorax and spine by lacing them up to the required tightness. From the strength of its framework, and from the ease with

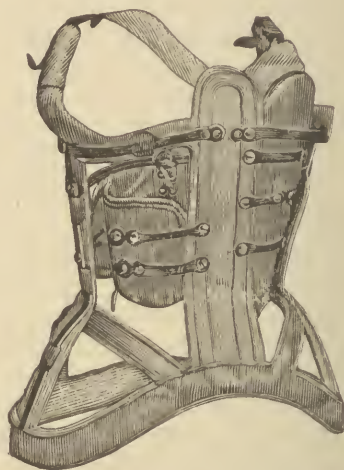
which it is adjusted to suit the requirements of the case, this instrument is a most suitable one to employ in the treatment of old established curvature, and in those cases in which the patient is unable to attend for frequent adjustments by the surgeon. Another instrument which is to a considerable extent self-adjustable, is that introduced by Mr. Wm. Adams (Fig. 761).

Fig. 760.



Spinal support with shields.

Fig. 761.



Spinal support with spring-plates.

It consists of a framework similar to that of the laced-shield support, but the shields are replaced by plates which are fitted in accordance with the condition of curvature, and which are kept in a state of constant pressure by means of springs connecting the plates with the central bar. This support is of great value both in the early stage of deformity, where there is a long curve, and also in long-standing cases in which the curvature is not very severe, but has become confirmed from the lengthened period of its existence.

The mechanical appliances above described are those which I am in the habit of employing; many other forms of support have been invented, but not having had any practical experience of their action, I cannot offer any opinion as to their value. The surgeon, in selecting an instrument, must see that it consists of a rigid framework with adjustable actions to give pressure at the exact spot required.

One method of treating lateral curvature that has been employed of late years, must be noticed on account of its very general adoption by those who have not had much experience in the treatment of this deformity. This method is that introduced by Dr. Sayre, and it consists in the application to the body of a plaster-of-Paris jacket, and in the daily use of self-suspension. The jacket is made by incasing the body in plaster-of-Paris bandages, whilst the patient is suspended by the head and arms. Daily suspension is also ordered as an exercise to gradually reduce the curves by stretching. Dr. Sayre argues that, by applying the jacket during extension, the stretching of the spine then obtained is permanently maintained; and in support of this theory he quotes cases in which the height of the patient was considerably increased after the application of the jacket. But it is evident that if the plaster-of-Paris jacket is a perfectly retentive splint, as Dr. Sayre declares it to be, self-suspension after the jacket is applied

can produce no result, since the spine is already rendered inextensible by the fixing support; on the other hand, if extension of the column can be obtained, then the jacket is an insufficient support, because any reduction of the curvature which results from the daily exercise is not maintained, for the spine must sink back to that condition in which it was when the jacket was applied. All forms of jacket which incase the body are unsuitable appliances to use in the treatment of lateral curvature, because they prevent the employment of those physiological measures which have already been described; valuable as the jackets may be in the treatment of caries of the vertebrae, when the one object of treatment is to fix the spine, their use in the reduction of lateral curvature is distinctly contra-indicated, for in this affection the object to be gained is not fixation of the column, but its restoration to the normal condition.

The treatment of lateral deflection of the spine resulting from simple *bending*, is best conducted by the use of exercises which strengthen the muscles of the back, and by attention to the general health. Mechanical appliances should if possible be avoided, but in cases such as that illustrated in Fig. 756, an instrument with laced shields will give the necessary amount of support. Lateral bending combined with lateral curvature, as in the case shown in Fig. 758, should always be treated as one of lateral curvature only, since the improvement of the curvature will be accompanied by increasing strength of the muscles, whilst if the muscular weakness alone receive attention, the displacement of the vertebrae, the most serious part of the condition, will be liable to advance. The case in question (Fig. 758) was treated on this principle, and resulted in complete recovery; the patient, when first affected with lateral curvature, had been treated with the plaster-of-Paris jacket, the retentive qualities of which appliance had induced muscular wasting, and had superadded lateral bending to the already existing lateral curvature. The possibility of this result from using the jacket is another reason for objecting to its employment in cases of lateral curvature; the case above quoted is by no means one of uncommon occurrence, several similar instances having come under my observation.

WRY-NECK, OR TORTICOLLIS.

Wry-neck results from contraction of the muscles on one side of the neck, the contraction being generally spasmodic in its nature, and either of congenital origin or developed in early infancy. The sterno-mastoid muscle is usually the most affected, but the scaleni and deeper muscles of the neck may also be implicated; in some few cases the latter muscles are the chief cause of the deformity. In the usual condition of wry-neck the chin is raised and directed towards the shoulder opposite to that of the contracted muscles, the head being so turned that the lobe of the ear on the side of contraction is brought forwards and downwards, whilst that on the other side is turned backwards and upwards, the distance between the two ears and the centre of the sternum showing a considerable difference on measurement. The usual position of the head in this deformity is illustrated in Fig. 762. When the muscular contraction is allowed to remain unrelieved, the features become implicated in the deformity as age advances. This complication results from acquired contraction of the platysma muscle and the muscles of the face; the corner of the mouth is drawn downwards, the cheek is flattened, the lower lid is depressed, and the eyebrow is on a lower level than that of the opposite side. The occurrence of this distortion of the face necessitates the early removal of the contraction of the muscles of the

neck, since the distortion of the face, when once acquired, can never be completely removed. The most effectual method of overcoming wry-neck dependent upon shortening of the sterno-mastoid muscles, is the employment

Fig. 762.



Wry-neck.

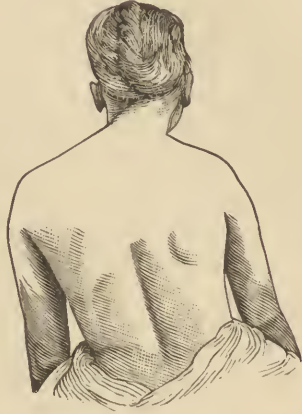
of tenotomy. The operation may, in the majority of cases, be limited to section of the sternal attachment of the muscle; in dividing this, the tenotome is entered at the inner border of the tendon and carefully passed behind it, care being taken not to push the point of the knife too deeply; the edge of the knife is turned when all the tissue which requires division is embraced by it, and the section is completed with a few strokes of the blade. When the whole of the muscle requires division, the clavicular attachment is reached by a second puncture made at the outer side of the tendon. This little operation is not unfrequently regarded as a rather formidable one, on account of the proximity to the tendon of the large veins of the neck; in its contracted condition, however, the tendon is in such bold relief that there need be no fear of wounding the vessels, if the precaution be taken of keeping the blade of the knife close to the surface of the part to be cut; to remove the risk of

wounding a vein, a blunt-pointed knife may also be used in making the section, as is done when dividing the tendon of the tibialis posticus. The wound is treated in the manner usual after tenotomy, the head being kept steady by fixing it with bandages to the shoulders; it is as well also to keep the patient in bed until the fourth day. After the wounds are healed, mechanical treatment must be commenced; in slight cases, a leather collar may be worn to support the head and keep the muscles extended, but in cases of greater severity, especially in those in which there is much contraction of the deeper muscles, a more powerful form of appliance is required. The most suitable instrument consists of a framework somewhat similar to the laced-shield spinal support; to the back lever of this instrument is attached a neck-piece with three racks and pinions, one giving lateral, another rotatory, and the third flexion-and-extension movements. A plate against which the occiput rests, is attached to the neck-piece, and to this plate are fixed two levers provided with movable pads; one of these levers fixes the head by pressing against the side of the frontal bone on the side of the contracted muscles, while the second is carried forward to the lower jaw, where the plate rests a little behind the chin on the side opposite to that of contraction; these levers are supplied with racks, which enable the head to be very perfectly carried into such a position as shall produce full extension of the shortened muscles.

A severe complication of wry-neck which has existed for many years, is the formation of lateral curvature. Deformity of the spine resulting from this cause is illustrated in Fig. 763. Three curves are generally formed, one in the cervical, a second in the dorsal, and a third in the lumbar region; rotation is not present in the early condition of this curvature, but it

becomes established as age advances. If not of long standing, the curvature of the spine is remedied by relieving the muscular contraction, but when the deformity has been allowed to continue unchecked until the adult age, the condition is very difficult to overcome. The use of a spinal support for many years, will, however, gradually improve, if not altogether reduce, the curvature, the contracted muscle having been of course first treated. The best form of instrument is that with spring-plates, recommended for the treatment of lateral curvature; one of these plates may be attached to the top of the central lever, and carried up so as to give support to the cervical vertebræ.

Fig. 763.



Curvature of spine from wry-neck;

A condition of wry-neck is very frequently met with after scarlet fever, rheumatism, and other acute attacks of disease. This condition generally depends upon contraction of the deep muscles of the neck rather than upon shortening of the sterno-mastoid. Tenotomy is not admissible in the treatment of such cases, but they yield very readily to instrumental measures. The chief interest attached to these cases is the somewhat close resemblance which they bear to the early stage of cervical caries, for at the commencement of the latter disease the head is very frequently carried to one or other side. The absence of local pain, and still more the perfect freedom of movement between the separate vertebræ, when the neck is flexed and extended, will generally suffice to establish the exact nature of the case, for we very rarely find caries of the vertebræ accompanied by free movement of the affected bones. It is as well in all cases of lateral deflection of the head observed after an attack of acute illness, to be somewhat guarded in making a diagnosis; fortunately, a similar course of treatment is applicable to both the conditions referred to, for a few days' rest will generally greatly improve the condition of wry-neck, whilst this treatment can be continued if the more severe affection be found to exist.

[*Wry-neck, with painful, convulsive spasm of the affected muscles*, has been successfully treated by the administration of bromide of potassium and the corrosive chloride of mercury, by Dr. Little; by the application of the hot iron, by Dr. C. K. Mills; by stretching the spinal accessory nerve, by Southam and Mosetig-Moorhof; and by resection of the same nerve, by De Morgan, Annandale, Rivington, and Tillaux.]

[CONGENITAL DISLOCATIONS.]

A few words may be said here in regard to the condition known as *congenital dislocation*, an affection most often met with in the hip, and very generally confounded with hip-disease. This subject has been particularly illustrated in the writings of Dupuytren, Carnochan, and Holmes, and more recently in excellent articles by Prof. Bennett, of Dublin, Dr. Buckminster Brown, of Boston, and Mr. William Adams, of London. Three theories have been advanced to account for the occurrence of the so-called congenital dislocation of the hip, viz., (1) that it is a true traumatic dislocation, resulting from injury inflicted before birth or during delivery; (2) that it is a deformity caused by spasmodic muscular contractions during foetal life, and analogous to club-foot; and (3) that it is due to a malformation of the acetabulum, with consequent displacement of the head of the femur owing to the deficiency of the socket in which it is normally held.

With regard to the first theory, it may be said that, though it is not denied that the femur or any other bone may be dislocated during delivery, yet, as a matter of fact, in most cases of congenital dislocation the labor has been a natural and easy one, and no pain or deformity has given rise to the suspicion that such an injury has been inflicted until long afterwards, not indeed usually until the child begins to walk. To the theory of spasmodic muscular action, of which the chief advocate has been M. Guérin, it may be objected that the affected joint is not found spasmodically contracted or fixed, either at the time of birth or subsequently, but that it continues freely movable in all directions—sometimes abnormally so—and that there is commonly no difficulty, even in inveterate cases, in restoring the head of the bone to its proper place, though it cannot be kept there. The third theory, that of original malformation, was entertained by Dupuytren sixty years ago, and is that which has secured the adhesion of most writers on the subject; it is indeed the only theory that satisfactorily explains the symptoms and course of the affection.

Congenital dislocation—the name, though not strictly correct, may be retained from motives of convenience—may affect one or both hips. As already mentioned, it is usually not observed until the child begins to walk, when, if one side only is involved, lameness without pain is noticed, and on measurement the affected limb is found slightly shorter than the other; as the child grows older, obliquity of the pelvis and compensatory lateral curvature of the spine follow. In double dislocation, the deformity is very striking and characteristic; the hips seem widened, and the trunk as it were sinks in between them; at the same time the pelvis is markedly tilted forward, the sacro-lumbar vertebræ becoming almost horizontal, with extreme lordosis and prominence of the belly, and the patient walks with a peculiar rolling or waddling gait which is of itself almost diagnostic.

The *treatment* of congenital dislocation of the hip is usually unsatisfactory. The limb can without much difficulty be pulled into position, but the defective acetabulum will not retain the head of the bone, and it slips out again as soon as the part is left to itself. That a cure is possible, is shown by a remarkable case reported by Dr. Buckminster Brown, of Boston, in which, by the adaptation of ingenious mechanical apparatus, the head of the femur was kept in its proper place until by pressure it had effected so much deepening of the acetabulum that there was no longer any tendency for it to escape. The treatment extended over more than a year, and though the result was a complete success, it could not have been so but for the fortunate combination of a patient much more reasonable and enduring than most

children, parents unusually intelligent and persevering in carrying out instructions, and a surgeon who, with large experience in orthopædics and great ingenuity in the adaptation of apparatus, was both able and willing to give the case unremitting personal attention.

In most cases, if the malformation affects only one side, it will be sufficient to direct the wearing of a high-soled shoe, so as to equalize the length of the limbs and prevent the development of lateral spinal curvature which would otherwise be inevitable. Mr. Adams advises that the patient should be made to lie down for at least half the day during all the period of active growth, and that he should practice suitable gymnastic exercises in the recumbent posture. In double dislocation, attempts have been made to prevent displacement by the application of a leather girdle or other compressing and restraining apparatus, but the remedy is irksome and inefficient. Tenotomy has been practised in these cases, by Guérin, Brodhurst, and others, but I confess that I do not see on what grounds; certainly in the examples of the affection which have come under my own observation, tenotomy could have been of no service. Excision of the hip is another operation which I cannot recommend in the treatment of congenital dislocation, although it has been adopted, and with alleged benefit, by Rose, Reyher, Heusner, Margary, and perhaps other surgeons.]

INFLAMMATORY AFFECTIONS OF THE BONES.

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THE bones were long considered as a separate system in regard to pathological alterations. It is only during the last fifty years that it has been well understood that their lesions are analogous to those of the soft parts, and that their pathological processes are developed in the same manner and lead to the same results. Experimentation on the one hand, and histological researches on the other, have finally established this analogy, which pathological anatomy had already demonstrated to Gerdy, to Cruveilhier, and to other authors who wrote in the first half of this century.

The ancients designated under the name of *caries* most of the alterations of the bones; at the end of the last century they distinguished *necrosis*, but in the first third of this century the greatest confusion still reigned in regard to inflammations of the bones; Boyer described only *caries* and *necrosis*, and, although speaking in a number of passages of inflammation of the periosteum and bones, it did not occur to him to give a special description of this inflammation. It was not until 1835, at the time when Gerdy created the word *osteitis* to designate inflammation of the bones, that a clearer idea arose as to the various alterations of which bone-tissue is susceptible. From this moment numerous works appeared on all sides upon the affections of the bones; and among the most important must be mentioned, at the outset, those of Chassaignac, of Nélaton, of Gosselin, of Klose, of Roser, of Volkmann, of Stanley, of Paget, of Ranvier, and of Lannelongue.

It is not possible, in this article, to dwell upon historical questions, and yet it should not be ignored that, even in the last century, notwithstanding the silence of Boyer and of the classical authors who followed him, there are found very important documents bearing upon the history of our art, which show that affections of the bones had already been considered at that epoch with much justness and profundity. Boerhaave and Van Swieten advanced propositions which appeared novel a century later. The first aphorism of Boerhaave bears upon the analogy of diseases of the bones with diseases of the soft parts. Inflammations of the periosteum and of the medullary tissue are afterwards not only mentioned but exactly outlined. The cause of the gravity of inflammations of the medulla is found, according to these authors, in putridity of the medullary tissue—a putridity

which they explain by the presence of fat and by the chemical properties of this tissue. As a corollary to these propositions, free incisions of the periosteum and trephining of the medullary canal are formally recommended, and antiseptic indications are clearly formulated.¹ In this work of doctrinal exposition and of criticism, which is very remarkable for the times, Van Swieten describes inflammation of the external periosteum and of the internal periosteum or marrow. He insists upon the lesser gravity of inflammation of the external periosteum, and dwells at length upon the infection produced by corruption of the medullary oil. This infection, starting from the marrow, passes through the bones, reaches the periosteum, and then infects it and spreads through the tissues of the members. Hence the need for very energetic treatment to arrest this medullary corruption and the infection which is its consequence. There is doubtless much which is vague in some of these descriptions, but it has appeared to me of interest to refer to these theories which, expressed in more modern style, are no different from those by which we are guided to-day. It is also interesting to recall the boldness of certain therapeutic precepts which we are very apt to consider new, and which are explicitly formulated in books which were classic a hundred years ago. But these precepts were rarely put into practice, and unfortunately remained as a dead letter to the majority of surgeons.

In this article I purpose to study inflammations of the bones in general, dwelling especially upon acute and spontaneous inflammations, since traumatic inflammations will be elsewhere studied² in connection with fractures, and since chronic inflammations will receive fuller treatment in the article devoted to scrofulous and tuberculous bone-lesions. Nevertheless, I shall examine the different forms of chronic osteitis, and I shall give some space to the chronic lesions which are the consequence and sequel of acute osteitis. In connection with this I shall take up questions heretofore little studied, such as the influence of osteitis upon the growth of the bones, and the remote consequences of acute inflammations occurring in infancy and adolescence.

One of the most important matters to bear in mind in the study of inflammation of bone, is the influence of age; these affections are so linked to the development of the skeleton that they differ entirely in infancy and in mature life. The study of the development of the bones throws special light upon these affections, and explains their character, their course, and their termination in a multitude of circumstances. It enables us to understand their seat of election in different parts of the bone, and explains their frequency in different bones or in different parts of the same bone. Therefore we should always remember the close relation which exists between the physiological processes of growth and the various pathological processes. This notion is indispensable to the interpretation of diseases of the bones; by it everything is set in order and simplified.

EFFECTS OF IRRITATION ON THE VARIOUS CONSTITUENTS OF BONES.

Bone is made up of three different tissues which enter into its structure to a greater or less extent, according to the age of the subject and according to the different regions. The periosteum, the bone-substance proper, and the marrow, are the constituent parts of bone. To these three tissues should be added a fourth, cartilage, which no longer exists, or at least exists only

¹ Hermann Boerhaave, *Aphorismes de Chirurgie, commentés par Van Swieten*, t. v. (*Des maladies des os.*)

² See Article on Injuries of the Bones. Vol. IV., page 1, *infra*.

in the state of a terminal layer, in the bone of the adult, but which, in the first period of life, plays a predominant part in the formation of bone-tissue. These tissues have different physiological functions, and are of unequal importance in regard to pathological processes. They are more exposed to inflammation as they are more vascular, and formed of a greater quantity of soft elements and young cells.

The presence of vessels in a tissue is not an indispensable condition in order that it shall undergo inflammatory changes, as was formerly believed, when the characteristic feature of inflammation was looked for especially in the modifications of the vascular system. The articular cartilages go through the first stages of inflammation, although they have no vessels; the cells proliferate and multiply in their capsules; their intercellular substance is modified and absorbed, and only at this stage do vessels appear in this transformed tissue.

It is none the less true, however, that inflammatory processes are infinitely more rapid and more evident in tissues rich in vessels, and formed of cells which resemble embryonic tissues. Under these conditions they pass rapidly on to suppuration, and they reach this termination all the more easily as the inflamed tissues are composed of young cells held together by an intercellular substance of less consistence, and traversed by numerous capillaries. It is, therefore, this greater or less abundance of young cells in the several parts making up bone, which explains their more or less active participation in the phenomena of osteitis.

EXPERIMENTAL STUDY OF INFLAMMATORY PROCESSES IN BONE.—In order to properly understand the processes of inflammation in bone, it is necessary to have recourse to experimentation upon animals; there is nothing so easy as to develop osteitis in its different degrees, and to reproduce its different forms, by subjecting one or another element of bone to irritation.¹

Thus it is possible to irritate the periosteum, the medulla of the central canal, or the spaces of the spongy tissue, and processes may be set up which, although differing one from the other, are always related by common characteristics. The following is what happens in the different tissues. If the surface of the bone be irritated by means of a sharp instrument, introduced through the flesh and carried along the diaphysis so as to make multiple punctures, lacerations, and separations of the periosteum, the bone will, at the end of two or three days, be found to be tumefied at the point where the periosteum has been wounded. At first there occurs an effusion of blood, but soon the periosteum is infiltrated, swells, and becomes thickened, and the more as the subject is younger. This thickening is due to proliferation of the cells of the deep layer of the periosteum, to which I have given the name of osteogenic layer because of its share in the normal formation of the bones and in their regeneration. This layer, which is scarcely perceptible in the normal state, becomes more apparent, and is usually seen in the form of a soft, homogeneous stratum, with a tufted appearance, when the periosteum is torn from the bone; sometimes it has the appearance and consistence of cartilage. This thickening of the periosteum by hyperplasia of the osteogenic layer is characteristic of plastic periostitis. Soon new bone-tissue, in quite regular lamellæ, or in nipple-shaped osteophytes, is formed on the surface of the bone, in such a manner as to produce an exostosis in cases in which a small surface has been irritated, or a hyperostosis if the periosteum has been separated from the greater part of the bone.

This newly-formed subperiosteal osseous tissue becomes organized like

¹ *Traité Expérimentale et Clinique de la Régénération des Os*, t. i. chap. v.

normal bone-tissue in the growth of the bone; the vessels which leave the deep surface of the periosteum and pass into the superficial layers of the bone, are centres of lamellar formations which thus mark the boundaries of the Haversian canals.

While this process is going on under the periosteum and by transformations of the osteogenic layer, modifications occur on the surface of the bone and in the compact layer which it is the more important to describe because they are characteristic of osteitis, properly so called. Regarded macroscopically, the surface of the bone becomes rugous, and the canals of Havers which open upon its surface enlarge, giving this surface a honey-combed appearance which differs completely from the polish which it presents in the normal state. The rugosities of the bone are caused first by absorption of the bone-substance in the region of the canals of Havers, but soon they result from the deposit of new bone-tissue.

The enlargement of the canals of Havers is the result of absorption of the bone-tissue by the medullary cells which normally line these osseous walls, and which under irritation proliferate with great rapidity in young subjects. Independently of this absorption along the canals of Havers, the compact tissue is eroded and irregularly perforated by medullary granulations which have the same origin, and which have a tendency to form lacunæ in every direction (*lacunar erosion*). Absorption of the old bone-tissue by the medullary cells is then the first stage of osteitis, but, as we shall see, this absorption is only temporary, and is soon followed by reconstitution of the bone-tissue. We see already that the most active tissue in the process of osteitis is that made up of cellular elements which are susceptible of rapid vegetation, as they are found in the period of growth on the deep surface of the periosteum and in the canals of Havers. These elements have much analogy with each other; they have the character of embryonal tissue, and are made up either of small cells (*medullary cells*), or of large cells with multiple nuclei (*myeloplaxes* of Robin). They are found alike under the periosteum and in the medulla, which leads Ranvier to say that the osteogenic layer is only a layer of the medulla, connected with the medulla of the central canal by the cells which line the walls of the canals of Havers.

But, in spite of the presence of analogous cells in the marrow and under the periosteum, these tissues must not be considered as identical. The deep layer of the periosteum has osteogenic properties incomparably more marked.

If, instead of the periphery of the bone, its central tissue be irritated—that is to say, the marrow which is contained in the cavity of the diaphysis—the following phenomena are observed: first, the perforation and the crushing of the medulla cause an effusion of blood, which is soon followed by induration of the medullary tissue. If the marrow is already yellow, the fat is absorbed, and the medullary tissue assumes the characteristics of foetal marrow. The medullary cells secrete only a more resistant intercellular substance, which increases the consistence of the tissue and gives it a sclerosed appearance. At the same time, what we have observed in the periphery of the canals of Havers takes place in the periphery of the medullary canal; there is absorption of the bone-substance and increase of the space occupied by the medulla.

Such are the phenomena which are seen after irritation of the different tissues constituting bone. But these phenomena represent only one phase of osteitis. When the process has once arrived at the point which I have just indicated, it may stop or continue, and in the latter case it may follow different courses. Either the process continues in the same direction, that is to say, in the way of progressive rarefaction of the bone-substance, when we have a *rarefying osteitis*, or, to this rarefaction there soon succeeds pro-

gressive reconstruction of the bone-tissue by the ossification of the osteoblasts found in the canals of Havers, and the bone-substance is seen to resume its original compactness and even to reach a state of greater condensation. Then we have a *condensing osteitis*, likewise called *restitutive* or *productive osteitis*.

Under other circumstances the hyperplastic medullary tissue soon produces pus. Leucocytes are formed in greater or less abundance, and accumulate in appreciable masses under the periosteum or in the medullary canal. They are also formed in all the canals of Havers which contain embryonal cells, and the osseous matter, being bathed in pus, cannot continue to live, but becomes more or less rapidly necrosed. As soon as the process takes this direction we have a *suppurative osteitis*, which is acute or chronic, according as it progresses rapidly or runs its course slowly. These forms of osteitis often follow each other, or are found at the same time in the same inflamed bone. We may produce them experimentally, and determine in this way the relations which they bear to each other. By experimenting upon young animals these different processes may be easily studied; they may be seen, according to the mode and degree of irritation, to proceed in regular succession or to follow an irregular course.

By abandoning to itself a mild osteitis, produced with exclusion of septic agents, reconstruction of the bone is often seen to follow rarefaction, after which everything is restored to order, and at the end of a few weeks the irritated bone has so fully resumed its normal characteristics that it is difficult to distinguish it from healthy bone. If the irritation have been often repeated and long continued—if, above all, it have been set up in an adult subject—reconstruction of the bony substance continues a long time, and the productive osteitis is not only reconstructive but also condensing. This is what is seen around old fractures.

Excess of irritation, produced by exaggeration of the traumatism or by the introduction of septic matters, occasions the formation of pus. This suppuration usually brings on necrosis of a greater or less part of the bone. The vessels contained in the canals of Havers, being able to adapt themselves only with difficulty to the changes induced by the inflammation, are obliterated, and the circulation is interrupted, whence results death of the portion of bone which they nourish. But here again we must consider the age of the tissue, and I have shown¹ that in young animals the compact osseous tissue may disappear by medullization in spite of suppuration of the marrow. A traumatism which will inevitably produce necrosis in an adult, will set up only a rarefying osteitis in a child.

The different forms of osteitis which we shall hereafter find associated in the majority of subacute or even chronic cases seen in man, are artificially produced in animals, and vary with the degree and mode of irritation in different parts of the same bone. They may even be found in different parts of the same bone after a single irritation. The degree of irritation diminishing in proportion as we recede from the point to which the irritating agent has been applied, we can appreciate the influence of the degree of irritation on the form of the process.

If a wound is made in a bone, and a foreign body is introduced by this wound and left in the medullary canal or in the spongy tissue of an epiphysis, the following disturbances will be observed: around the foreign body, the formation of pus; at a certain distance, rarefaction of the bone-substance and proliferation of the medullary substance; further off, the formation of new layers of bone under the periosteum, and ossification of the medulla. If the

¹ Op. cit.

foreign body be then removed, the process will be seen to follow a reverse course, and the normal state to be re-established little by little. The newly-formed layers of bone, sub-periosteal and intra-medullary, the latter especially, are gradually reabsorbed, whilst the granulations of the space which contained the foreign body are organized first into sclerous and then into osseous tissue.

Healthy bone-tissue, artificially or spontaneously inflamed by a traumatic cause, always tends to resume its former character, especially in young subjects. When a bone is subjected to an irritation extending to its different tissues, periosteum and medulla, or limited to one of these, it is found at the end of two or three months that everything has been restored to order, and it is hard to recognize the traces of the inflammation if the bone has enlarged materially in that time. By the time that the process of physiological growth has resumed its course, the bone then formed has been by degrees covered with regularly formed layers from the periosteum, and absorption has taken place in the medullary canal so as to cause the disappearance not only of the intra-medullary ossifications due to artificial inflammation, but also of the deep layers of the old diaphysis. In this incessant work of deposit under the periosteum and of absorption in the central canal, which characterizes the normal increase of the bone, all the osseous tissue existing at the time of the experiment disappears, and is rapidly replaced by entirely new bone.

Fig. 764.



Rarefying osteitis. (After Gerdy.)

Fig. 765.



Condensing osteitis. (After Gerdy.)

But this disappearance of the traces of traumatic osteitis, a demonstration of which is seen every day in fractures in children, does not occur in the same way in adults. The new formations due to irritation of the subperios-

teal tissue, or of the medullary tissue, are much more stable, and sometimes persist indefinitely, as is observed in the callus of adults or old people.

In spontaneous osteitis, or in artificial osteitis in which an attempt has been made to realize, by repeated and varying irritations, the multiplicity of forms which I have already mentioned, the return to the normal state takes place but slowly, and is not possible if sequestra are incarcerated in the medullary cavity, or if their expulsion has been followed by great loss of substance.

If experiments upon animals furnish an explanation of the process of osteitis, they cannot give us results like those which we see in the old osteitis of men, whether spontaneous or traumatic. It is when the process lasts several years that we see those forms which have served as types for those who have described them; those hypertrophied bones made up of rarefied bone-substance without a distinct medullary cavity, or those bones strewn with projecting osteophytes and made up of a white compact substance having the appearance and consistence of ivory.

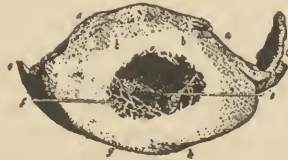
The accompanying figures, taken from Gerdy,¹ represent these two forms of osteitis. Fig. 764 represents an hypertrophied tibia, the surface of which is rough and uneven, and its osseous substance composed of rarefied tissue, with a very thin compact layer at the periphery. This layer, notwithstanding the osteophytic verrucosities which cover it, is reduced to a slight thickness, and has not a composition comparable to that of normal bone. This is shown in Fig. 766.

Fig. 766.



Transverse section of bone affected with rarefying osteitis. (After Gerdy.)

Fig. 767.



Transverse section of bone affected with condensing osteitis. (After Gerdy.)

In contrast to this rarefying osteitis, Fig. 765 represents another tibia, the surface of which is covered with elevated osteophytes, especially along the edges of the bone. Under this osteophytic layer the original bone-tissue has undergone the process of condensing osteitis. In section (Fig. 767) it is seen to be formed of a white compact layer of dense texture, without visible bloodvessels.

The productive osteitis which gives rise to this condensation of the osseous tissue, is sometimes carried to such a point that the bone acquires an extreme hardness. The production of bone may extend into the medullary canal, which becomes more and more narrow, and is finally obliterated. Then the bone becomes very dense, and exactly resembles ivory.

DIRECT AND INDIRECT IRRITATION OF THE VARIOUS ELEMENTS OF BONE.—We have as yet examined only the direct effects of irritation upon one of the elements of bone, that is to say, the effects produced upon the tissue which has been directly and immediately subjected to contact with the irritating agent. But this irritation is not limited to the point touched, it extends more or less rapidly, and with more or less intensity, to other parts, and may react upon the whole organ. In this extension the irritation is weakened, and

¹ Gerdy, *Maladies des Organes des Movements*. (Plates III. and IV., reduced.)

produces varying effects. Intense and destructive at the point touched, a little further off it leads to absorption of the calcareous matter, and at a distance still further removed from its point of departure causes immediate plastic processes.

Let us take an example: if a foreign body is introduced into the medullary canal of the diaphysis of a long bone of a young animal, a focus of suppuration is formed at its site; the medullary substance in contact with it is destroyed or transformed into purulent granulations, and the bony laminae in contact with it become more or less necrosed. But at about a centimetre beyond the point of suppuration, the medulla is harder and begins to ossify; in the bone, beyond the necrosed lamina, there is rarefaction, the canals of Havers being enlarged; under the periosteum, the irritation being still more feeble provokes secondarily a hyperplastic process, which continues and soon manifests itself by a considerable increase in the thickness of the bone. The new subperiosteal mass sometimes attains a thickness of from seven to eight centimetres, and ensheathes the whole of the old diaphysis. This indirect irritation of the periosteum is more fruitful of ossification than direct irritation, which is apt frequently to pass its limits and induce suppuration. This is a fact which it is important not to forget in interpreting the phenomena which accompany regeneration of bone, and which we shall return to hereafter in connection with necrosis.

The same physiological fact is observed in the treatment of pseudarthroses by the seton. When a false joint is traversed, that is to say, the seat of an ununited fracture, suppuration is provoked along the course of the seton, and even the osteoid products already formed may disappear in its neighborhood; but at a little distance, and all around, in all the ossifiable tissues, there occurs a hyperplasia which results in the formation of osseous tissue, and in this way consolidation of the fracture is secured. Victorin Ollier¹ has well demonstrated the influence of different degrees of irritation upon the course of the process of ossification, and has shown experimentally that this process may be hastened or made to retrograde according to the intensity and permanence of the irritation.

I shall mention hereafter, in speaking of the influence of osteitis upon the growth of bones, the varied effects of irritation of the epiphyseal cartilage, according as it is direct or indirect. Let me only mention here that persistent and moderate irritation of one of the elements of bone manifests itself in a more abundant proliferation of the organs of growth, and finally by hypertrophy of the bone in length or in thickness, provided that it does not act directly upon the epiphyseal cartilage. Lacerations of the periosteum, bruises of the medulla, the various wounds of bone in the middle of the diaphysis in young subjects, provoke indirectly irritation of the physiological zone of proliferation, which is soon manifested by an increased length of the part.

The processes of experimental osteitis, and those of traumatic osteitis in man, are considerably influenced by septic agents and the general state of health of the subject. A traumatism which will provoke only hyperplastic processes and increase of medullary ossification in a healthy individual, will produce a suppurative inflammation of the medulla, and processes which are fruitless so far as ossification is concerned, in one who is ill or whose nutrition is impaired. It is necessary then to consider, in determining the causes which vary the course of osteitis, not only the degree and the mode of irritation, but also the physiological and pathological nature of the soil; that is to say, the state of the patient's constitution and general health.

¹ Vict. Ollier, *Du cal et de ses modifications sous l'influence de l'irritation*. Thèse de Montpellier, 1864.

MINUTE PHENOMENA OF OSSEOUS INFLAMMATION; ABSORPTION OF BONE-SUBSTANCE BY MEDULLARY CELLS; ACTION OF OSTEOPLASTS.—We have seen that enlargement of the canals of Havers and absorption of the bone-substance constitute the first macroscopically appreciable phenomenon, and therefore form the first stage of osteitis. But how does this absorption take place? By what mechanism is it accomplished? What is its essential organ?

In this process it is the most recent bony lamellæ, the most newly-formed layers of osteoplasts, which are first absorbed. In the lamellar system of the Haversian canals, the most central are the most recent, and those which of necessity disappear first. Under the periosteum, the fundamental lamellæ are absorbed in like manner, the most recent first. It was believed for a long time, following Virchow, that the cells of the osteoplasts contained in these lamellæ took an active part in this absorption, and were the point of departure of a new proliferation. But the most recent researches do not favor this hypothesis. It has not been possible to detect these transformations of the osteoplasts, which had been acknowledged more from analogy perhaps than from direct observation; and Ranvier, who some years ago had adopted the first theory, now acknowledges that it is very difficult to recognize this process, that is to say, the return to vegetative life of the cells contained in the bone-corpuscles. "It is very difficult," say Cornil and Ranvier,¹ "to comprehend the exact cause of the absorption of bone in osteitis. If, in intense osteitis, there are sometimes bone cavities which contain a large cell or several cells, resulting from multiplication of the primitive cell, in such a manner that the enlarged cavity may open into a medullary space, nevertheless this is not the habitual method of absorption of the bony trabeculæ." Kölliker, Wagner, Busch, and others, in Germany, and Lovén, in Sweden, have combated the theory of Virchow, and have arrived at the conclusion that the bone-corpuscles disappear without leaving any trace, and especially without returning to the state of young cells fitted for proliferation. It was then asked, what was the agent of this absorption, and Kölliker suggested that the large cells of the medulla, the cells with multiple nuclei or *myélopaxes* of Robin, were its essential agents. These cells, which are endowed with special chemical properties, have for their function to dissolve the contiguous bone-substance, whence the name *osteoclast* or *osteophage* which he has given to them. The special action of these cells does not appear to me to have been demonstrated: the rapidity of the absorption of bone is not in proportion to their number or their dimensions, and they are not always found at the periphery of the medullary granulations which penetrate into the lacunæ of Howship. According to Ranvier, these cells, the so-called osteoclasts, are found in the course of osseous trabeculæ in the process of growth, as well as in the course of those which are being absorbed in inflamed bone. I do not, therefore, attribute the property of absorption of bone-tissue to any particular cell of the medulla, but to all the young cells which constitute medullary granulations, and especially to the vascular element of these granulations.

In regard to the changes which take place in the soft parts of the bone (periosteum, medulla), they are analogous to those which are seen in all inflamed tissues, while having certain peculiarities dependent upon their structure. The external layer of the periosteum is infiltrated and thickened, but it is in the osteogenic layer that the most important phenomena take place, which determine the form of the osteitis. These elements return to the embryonic state, and, according to the direction which the process takes,

¹ Cornil et Ranvier, Manuel d'Histologie Pathologique, 2e édit., p. 391.

give rise to the formation of pus, or to a new bone-formation, which is only an exaggeration of the phases of normal ossification. In the medullary tissue analogous processes occur: the small cells multiply, and the large cells become more apparent and at the same time more numerous. The inter-cellular substance assumes at a certain period a fibrous appearance, becomes sclerosed, and afterward produces trabecular bone-formations, which persist or are absorbed according to the course of the inflammation.

INFLAMMATION OF BONE IN RELATION TO ITS CONSTITUENT TISSUES; PERIOSTITIS; OSTEOMYELITIS, ETC.

The multiplied vascular relations which exist between the different tissues constituting bone, and the continuity of the subperiosteal osteogenic layer with the central medullary tissue by means of the cellular elements contained in the canals of Havers, establish a physiological solidarity between these different elements, and explain the closeness of their pathological relations. Inflammation is communicated from one to the other by reason of the similarity of their anatomical elements, and of the abundance of bloodvessels which traverse them. Yet for a long time inflammations of the periosteum and of the medulla were described separately, and before Crampton had created the word *periostitis*, descriptions had been given of inflammation both of the external membrane of the bones (Boerhaave, Van Swieten), and of the medullary membrane. Superficial inflammations were attributed to the periosteum, deep ones to the medulla. In our day, these distinctions have been made more precise, and the majority of authors have described periostitis and osteomyelitis separately. The name *medullitis* has also been given to inflammation of the medulla of the central canal. Inflammation starts, in fact, in either one or other of the tissues constituting bone, and may remain limited to it for a certain period. At other times it attacks almost simultaneously all the tissues of the bone, or may pass from one to the other with great rapidity, when it is difficult to classify the case either among inflammations of the periosteum or among those of the medulla. It is now no longer a periostitis or an endosteitis; it is an inflammation of the bone, or, in other words, an *osteitis*.

The term osteitis is not applicable solely to inflammation of the substance of bone. As has been said above, bone-substance inflames only by means of the soft and vascular elements which it contains; whence, though it is the characteristic substance of bone, it constitutes the least important element in its pathological processes. On this account it has sometimes been said that in inflammation of bone there is only periostitis or medullitis.

We should in regard to osteitis refrain from disputing about words, and should not press too far the spirit of systematic classification. Therefore, while admitting isolated inflammation of the periosteum, and of the central medulla, I shall occupy myself especially with inflammation of bone. I shall describe it under the name *osteitis*, this word signifying not inflammation of bone-substance, but inflammation of the osseous tissue, consisting at once of periosteum, of medullary tissue, and of bone-substance, properly so called.

Having made these reservations in regard to the inter-connection of inflammations of the various elements of bone, I shall give a special description of periostitis and of osteomyelitis. The opinions of surgeons have often differed in regard to the share of these separate inflammations in the pathology of the osseous system; sometimes they have exaggerated the importance of

periostitis; sometimes they have been able to see only osteomyelitis. We shall see that it is always useful to take both of them into account, not only as a matter of theoretical interest, but also from the stand-point of therapeutics. Independently of the differences in inflammations of bones according to the anatomical element involved, distinctions must be established according to the region of the bone which is implicated. These distinctions are, from a practical stand-point, even more important than the former.

A long bone (let us take the femur for example) is made up during the period of growth, that is to say, during the period of life when the exposure to affections of the bones is greatest, of three distinct pieces; the diaphysis and the epiphyses. These pieces are separated by the epiphyseal or connecting cartilages, which, isolating them anatomically, form a more or less resistant barrier to the propagation of their respective inflammations.

It is important to distinguish these several inflammations. That of the diaphysis bears the name of *diaphysitis*, that of the epiphyses will be called *epiphysitis*. The different relations of these two portions of the bone, and the connection of the epiphyses with the terminal articulations, impress upon these affections a different course, explicable by their anatomical connections.

When the whole of a bone is inflamed, when the diaphysis and its terminal epiphyses are invaded, the disorder bears the name of *panosteitis*, that is to say, inflammation of the whole bone. This total inflammation is more rare than one would at first believe. The large bones of the extremities are rarely involved from one articulation to the other. It is seen rather in the small bones, and in the short bones which have only a single centre of ossification and no intermediate cartilage between their different prominences.

Spontaneous inflammations of the bones occupy seats of election, corresponding, as I have already said, to the points of greatest activity of physiological development. The morbid predisposition is, all other things being equal, in direct ratio to the activity of proliferation of the anatomical elements. The regions of the bone at which growth is chiefly taking place at any given period, are by that fact peculiarly predisposed to become the seats of pathological new formations, and especially of acute or chronic inflammations.

Spontaneous inflammations of the bones are peculiarly diseases of childhood and adolescence, that is to say, the period during which the bone grows. It is at this age that the action of cold, forced exercise, fatigue of the skeleton, or juxta-epiphyseal strain, gives rise, under the influence of a scrofulous or rheumatic predisposition, or of a general, systemic poisoning, to those acute or subacute lesions which are chiefly characterized by being produced where the formative activity is most developed—in the neighborhood of the juxta-epiphyseal portions of the diaphysis, where increase in length takes place, and under the periosteum, where increase in thickness occurs. Hence the frequency of those forms of osteitis, osteo-periostitis, and osteomyelitis, which I have called juxta-epiphyseal, and which are seen not only at the extremities of the diaphyses of long bones, but also upon the borders or surfaces of flat and short bones which are connected with a cartilage of development (spinal border of the scapula, crest of the ilium, posterior third of the calcaneum, anterior extremities of the ribs). The crest of the ilium and the spinal border of the scapula, in young subjects, are constituted by an epiphyseal margin which is separated from the diaphysis by a connecting cartilage. Inflammation of the diaphyseal border is the analogue of inflammation of the terminal portions of the long bones; it is also a juxta-epiphyseal osteitis. Marginal osteitis is an inflammation of the epiphysis.

The short bones which have no epiphysis, and the flat bones which have only one centre of ossification, increase by their periphery. Peripheral appo-

sition is the general formula which I have reached in my experiments upon the growth of bone; interstitial growth is absent, or is insignificant.¹

Marginal osteitis of certain flat bones (angle of the jaw), and sutural osteitis of the cranium and of the bones of the face, are to be classified, during childhood and adolescence, with the osteitis of growth.

Juxta-epiphyseal osteitis is acute or chronic. When acute, it often overleaps the limits of the connecting cartilage which has held it back for a certain length of time; then it is propagated to the epiphysis and attacks the terminal articulation. When chronic, it threatens the articulations less directly, but invades them ultimately, sooner or later according to the relations between the connecting cartilages and synovial membranes.

A mistake has sometimes been made as to the significance of juxta-epiphyseal osteitis. Because the grave and infective form has been most carefully described,² it has been supposed that this affection is no other than that which is known under the names of diffuse phlegmonous periostitis, separation of the epiphyses, typhus of the limbs, etc. This is an error which I have always combated; for ever since the beginning of my researches, in 1860, I have seen chronic and benign forms of the disease.

The word juxta-epiphyseal is a qualificative, which indicates the seat and not the nature of the affection. My experimental researches upon the growth of bone, while demonstrating the part of the connecting cartilage in increase of height, have led me to attach the greatest importance to inflammatory lesions situated at the edges of this cartilage, in the spongy tissue of the diaphysis. This newly formed spongy tissue, very vascular and united to the cartilage by a spongy layer which is not yet bone, but which no longer has the cartilaginous structure, is the portion of the bone in which the most active transformations take place during the period of growth. Upon the edges of the cartilage, the phenomena of cellular proliferation are accomplished with the greatest rapidity; transformation of cartilage-cells into marrow cells and into osteoblasts; transformation of these osteoblasts into bone-corpuscles; constitution of the web of the bone and formation of spaces filled with marrow; in fine, incessant increase in the height of the bony column. The marrow contained in the spongy tissue is very vascular; it is of a rose-color, and not charged with fat; it communicates with the marrow of the central canal, and, on the other hand, is connected with the periosteum by numerous vascular canals.

This spongy tissue makes up the expanded portions of the diaphysis, and is often the seat of acute or chronic inflammations, to which, under the influence of the physiological perturbations or the traumatic causes which we shall hereafter examine, the incessant transformations to which it is subject expose it. Inflammation may be developed in these various layers, at a greater or less distance from the connecting cartilage. If it attacks the cartilage, it alters its tissue, disturbs its nutrition, disintegrates it, and puts a more or less complete stop to the growth of the bone. If it does not attack the cartilage directly, its evolution will not be disturbed, but the inflammation may travel in a different direction, towards the central canal of the bone, or may advance towards the superficies and then invade the sub-periosteal layers.

I have given the name juxta-epiphyseal to that expanded part of the diaphysis which is included between the central canal and the connecting cartilage, and it will suffice to bear in mind its structure and its relations in order to comprehend its importance in relation to osseous pathology.

¹ Recherches expérimentales sur le mode d'accroissement des os. (Archives de Physiologie, 1872.)

² Gamet, De l'ostéo-périostite juxta-épiphysaire. Thèse de Paris, 1862; Sezary, De l'ostéite aiguë chez les enfants et les adolescents. Thèse de Paris, 1870.

The connecting cartilage is intimately adherent to the periosteum, with which it is continuous and blended at its circumference. The older writers even considered it as a dependency of the periosteum. This continuity is well seen in separations of the epiphyses, when the extremity of a diaphysis separated from its cartilage breaks through the ensheathing periosteum, and protrudes through the tear in the midst of the muscles. In this sudden separation there remains on the side of the cartilage the spongy layer, and under the periosteum the osteogenic layer, which is very easily seen in young children, and the deep parts of which have already undergone the first stage of ossification. There is also under the periosteum a spongy layer which is continuous with the same layer at the level of the cartilage.

At the terminal portions of the diaphysis there is also found the principal zone of growth in the bone: near the cartilage, the elements of growth in length; under the periosteum, the elements of growth in thickness. This zone of physiological proliferation is also the zone of election of pathological processes. And we must not only consider these processes at the periphery of the bone; corresponding incessant transformations take place in the cavities of the spongy tissue during the whole period of growth.

As the seat of the most active growth of the bones, the juxta-epiphyseal expansion is, by this very fact, the region most predisposed to a variety of inflammations. Related on the one hand to the connecting cartilage, on the other to the central canal of the medulla, and communicating readily with the periosteum by numerous vascular openings, it constitutes a central focus whence inflammation may readily radiate in all directions, except in that of the epiphysis, where the cartilage arrests it for a certain length of time. The inflammations which are produced in the spongy tissue, on the border of the connecting cartilage, take the form of osteo-myelitis, and differ from medullitis or osteo-myelitis of the central canal inasmuch as they cannot progress as rapidly, stopped as they are by the walls of the vacuoles of the spongy tissue. They differ from them above all in that they may easily show themselves under the periosteum, from which they are separated, at the edge of the cartilage, by only a thin layer of compact tissue, which is easily medullized. This explains the frequent spontaneous issue of pus under the periosteum, coming from the cavities of the spongy tissue, and enables us to understand at the same time the error which may be made as to its true origin.

It is in this region, under the periosteum or in the spongy tissue, that the majority of inflammations of the diaphysis begin during the period of growth, spreading through the medulla and the periosteum to the whole of this portion of the bone, and giving rise to the various lesions which we are about to study.

The idea of juxta-epiphyseal osteitis then appears to me one of the fundamental points of the pathology of bones; wherefore I shall not cease to call attention to its nosological significance and to its therapeutic consequences. The juxta-epiphyseal portion is much more frequently than the adjacent epiphyseal tissue the point of departure for the acute osteitis of childhood and adolescence. The proliferation of ossifiable elements, and the growth of the bone which is its consequence, are not equal on the two faces of the connecting cartilage. They are much more marked on the diaphyseal face, whence arises a permanent physiological congestion which prepares the ground for pathological attacks. The length of the bone derived from the epiphyseal faces of its two connecting cartilages represents, on an average, hardly the fifteenth of the length gained from the two diaphyseal faces of the same cartilages.

But the bone grows not only in length, it grows also in thickness by the

successive ossification of the osteoblasts furnished by the osteogenic layer of the periosteum. Although less obvious than the increase in length, this increase in thickness goes on constantly until the consolidation of the epiphyses with the shaft, and continues insensibly for a long time afterwards.

This activity of the subperiosteal elements explains how the internal surface of the periosteum is also frequently the point of departure for osseous inflammations, which may be limited, or may extend. In the latter case, they spread all round the bone, and may reach the medulla through the juxta-epiphyseal regions, bringing about those isolations of the diaphysis, or those more or less extensive necroses, which so often necessitate our interference.

The central medulla may also be the point of departure for acute inflammations, which immediately become grave because of the facility of their propagation to the whole of the bone, and of the favorable conditions which they present for pyæmie or septic poisoning. A continual work of absorption and deposition of bone-substance takes place on the internal face of the medullary canal; whence the disposition of this region to be also a point of departure for inflammations of bone during the period of growth.

Independent of the physiological causes which explain the origin and the places of election of inflammations of the bones, we must concede a considerable part to traumatisms, and not only to violent traumatisms, which are relatively rare, but also to those slight and transiently painful traumatisms which, in spite of their frequency, very constantly pass unperceived in young children.

The causes which set up, in delicate and scrofulous children, juxta-epiphyseal osteitis, have not been adequately appreciated, and, without seeking to explain its mechanism, it has been deemed sufficient to say that it is the result of the scrofulous diathesis or of a tuberculous affection. What explains to my mind this localization in a multitude of cases, is the juxta-epiphyseal strain produced by violent movements of the articulations, and by the falls which are so frequent in early age. Violent movements of the joints in young children do not generally produce appreciable articular lesions, but they react upon the bone above the connecting cartilage, that is to say, upon the spongy tissue of the juxta-epiphyseal region, which is the weakest part of the bone, and the least capable of resisting twists, exaggerated compression, or forced movements. Under the influence of these different traumatisms, there take place in the juxta-epiphyseal bone-tissue, crushings, trabecular fractures, separations of the periosteum and of the diaphyseal cartilage, which may be the starting-point of any of the forms of osteomyelitis.¹

The bone-cells of the epiphyses themselves likewise feel the effects of these shocks and violent movements, but here their effects are less apparent in experiments on the cadaver. However, they explain the development of epiphyseal osteitis, which is so often the origin of acute or fungous arthritis in young subjects.

Juxta-epiphyseal osteitis, developed in the long bones of the limbs, is usually single, but is sometimes double in the same bone. It passes from one end of the diaphysis to the other, either along the periosteum or along the medullary canal. Usually the inflammation leaves traces of its passage along the whole of the diaphysis, by giving rise to more or less appreciable suppurations of the periosteum or medulla; but at other times it traverses the diaphyseal tube without stopping there, giving rise perhaps to a few osteophytes under the periosteum, or to a few medullary ossifications, and going on to suppuration only in the two ends of the diaphysis, in the juxta-

¹ De l'entorse juxta-epiphysaire (*Revue Mensuelle de Médecine et de Chirurgie*, 1881).

epiphyseal spongy tissue. There are then two distinct centres of suppuration, one at each end of the bone. This is the variety of osteitis which I designate under the name of bipolar. This invasion of the two juxta-epiphyseal regions of the same bone is frequent in the tibia.

GENERAL SYMPTOMATOLOGY OF ACUTE INFLAMMATIONS OF BONE.

Inflammations of bone are sometimes very difficult to diagnosticate, because the organs attacked lie so deep. In some cases chronic inflammations follow so slow a course, and give rise to so little pain, that they are not diagnosticated until the cold abscesses which they cause appear in sight. As to acute inflammations, they may be confounded with phlegmons of different origin.

We shall here study especially acute and subacute inflammations; chronic inflammations are associated with serofulous and tuberculous lesions, or with syphilis, and are described in other articles.

The name periostitis is applicable to an inflammation of the totality of the periosteum; but, as I have already said, it is on the deep face of the periosteum, in the osteogenic layer in young subjects, and in the deep lamellar layer in old subjects, that the phenomena of inflammation oftenest occur. The fibrous external layer is only exceptionally the primary seat of inflammation, and still more exceptionally its exclusive seat. Inflammation may nevertheless develop on its external surface, and outside of it, in the parosteal layers.

Especially after traumatism may there be observed over superficial bones, such as the tibia, the ribs, the cranium, etc., external inflammations which may simulate true osteitis. An abscess forms, it is opened, and the bone is not found denuded, but only the periosteum thickened at this point. These are the inflammations which have been called external periostitis by Gaujot and Duplay, and which I long ago described under the names of *inflammation of the parosteal layers*, and of *parostitis*. This variety of inflammation undoubtedly exists, but one must not be in too great haste to admit its presence when there are at the same time signs of periostitis or of osteitis. One often believes at first that the bone is intact; but on searching carefully, a little denuded point is found which has been the origin of the abscess that was found spread in front of the periosteum. In consequence of a contusion, the periosteum may have been bruised over a considerable extent, and torn in a single point alone, where the force has been more directly applied. From this point the inflammation starts, and this osteitis, notwithstanding its slight extent, will keep up suppuration in the future. Therefore it is not well, in these parosteal inflammations, to be too quick to deny the participation of the bone. Whenever suppuration, developed on the surface of a bone, continues for a long time, it is advisable to search carefully for its starting-point, and to suspect that it is in the bone itself. Search conducted with this in view will usually be crowned with success.

In case a contusion of the periosteum, or spontaneous inflammation of its external layer, should give rise to a persistent swelling around a bone, the subjacent osseous layers, those which are immediately under the periosteum, feel more or less the effect of the propagation of the inflammation. There may be produced here secondarily a subperiosteal abscess; or, if the inflammation do not go so far as suppuration, layers of osteophytes are formed under the periosteum. Chronic inflammations developed around a bone produce this latter result; old ulcers of the leg give rise ultimately to hypertrophy of the bone, or at least to signs of plastic periostitis.

There may then be described two varieties of periostitis, external perios-

titis and internal periostitis, or endo-periostitis. The latter is the more common and the more important, because of the anatomical relations of the deep layer of the periosteum with the other constituent tissues of the bone. Besides, this layer is never inflamed without more or less participation of the fibrous layer in the inflammation; so that it is not worth while to try to separate that which is always more or less united. It is best simply to distinguish from periostitis proper, inflammation of the parosteal layers, which in certain cases is found to have peculiar characteristics, remaining independent of the bone and without appreciable influence upon it, unlike true inflammation of the periosteum, which is always propagated more or less to the other elements of the bone.

In bones which are superficial and easily accessible, osteitis manifests itself by an increase in size, and by pains which in certain bones are characteristic. The bone swells, but this increase in volume is not due to the bone-substance itself; it is the result either of thickening of the periosteum or of infiltration of the parosteal layers, that is to say, of the cellular tissue which surrounds it. Under the influence of this double cause a diaphysis may attain an enormous size; if the irritative process be long continued in a tibia or femur, the diameter of the bone may, after a certain time, appear at the central part double or even treble its normal size. This thickening is only apparent; it is made up in its deepest part by the osseous layers under the periosteum, which themselves are covered by the thickened fibrous layer of the periosteum, and more externally by the thickening and infiltration of the parosteal layers (muscle and connective tissue). This last constituent of the swelling of the bone is very variable, and tends moreover to disappear gradually as the inflammation subsides. When the bone is subcutaneous, this thickening of the periosteum, diffuse or limited, is accompanied by heat appreciable to the hand. It is more or less painful, according to the course of the inflammation. Painless, or nearly so, in the slow and chronic forms, the periosteal swelling is accompanied by acute pain, with nocturnal exacerbations, when the course of the affection is acute or subacute. These pains are increased by pressure, and may become very severe in certain regions. They increase in intensity when pus is formed under the periosteum. They are of a nocturnal type, but in certain regions they are almost continuous, and are accompanied by high fever and all the signs of deep inflammations. The periosteum, which forms a continuous membrane around the bone, constitutes a barrier which is long impassable to the products of inflammation. There is, therefore, strangulation of the inflammatory tissues; and, although the resistance of the periosteum is infinitely less than that of the bony case of the diaphysis, it is easy to understand the acuteness of the pains and their persistence, as long as the periosteum is not naturally perforated or artificially incised.

There is nothing so variable as the general symptoms and reaction in inflammations of the periosteum; wanting, or almost wanting, in syphilitic periostitis and in some cases of periostitis of traumatic origin, these symptoms develop with rapidity, and assume a very grave appearance, in the acute periostitis of childhood and adolescence. Sometimes, indeed, the general phenomena precede the local symptoms, as we shall see in connection with infectious periostitis. What characterizes in a general way inflammation of the periosteum, is the tumefaction of the bone, which appears as the initial phenomenon, or at least at the very beginning of the local manifestations, and, further, the superficial seat of the pain. As to its intensity, it is relatively less than in the more deeply seated osseous inflammations.

These two characteristics are manifested often enough at the outset of the inflammation to justify the statement that the part affected is the periosteum.

But in a considerable number of cases it is not possible to pronounce with certainty upon this point, and one should even speak with reserve, on account of the anatomical and physiological relations of the different tissues of the bone.

Inflammation of the central medulla or of the spongy tissue of the bone (*endosteitis*) is manifested from the beginning by dull and deep-seated pains. These soon assume a more or less acute character, and are cutting or gnawing; but what distinguishes them for a long time, when the patient is able to give a good account of his sensations, is their deep character, their intra-osseous situation.

When they declare themselves without anything being apparent to sight or to touch on the surface of the bone; when neither periosteal nor parosteal swelling can be distinguished, nor excessive tenderness on pressure, a diagnosis of osteo-myelitis or of osteitis beginning in the central part of the bone, should be made. If it be limited to the expanded portion of the bone, there is an osteo-myelitis of the spongy tissue, a juxta-epiphyseal osteitis; if it extend along the bone, if it correspond to the region occupied by the central marrow, the diagnosis of medullitis should be made. Often it will be found more or less in the two extremities of the diaphysis, the central portion being painless or having very little pain. This localization of pain in the two extremities of the diaphysis calls for a diagnosis of bi-polar osteo-myelitis.

In some cases, before the appearance of the external, that is to say periosteal, swelling, these deep bone-pains are accompanied by a slight hydrarthrosis in the adjoining articulation or articulations. This is a valuable sign for the recognition of osteo-myelitis at its outset.

But these deep pains, coinciding with an absence of periosteal swelling and of superficial pain, mark often only a very transient stage of the disease. Soon the periosteum swells and becomes sensitive, the parosteal layers are infiltrated, and the characteristics are observed which I have assigned to periostitis. But, if one has not witnessed the onset of the attack, and followed the development of the local manifestations, it is not possible to diagnosticate the initial lesion, and thus to say whether there has been originally a periostitis or an osteo-myelitis. Then the diagnosis of osteitis is the only one acceptable from both a theoretical and a practical point of view.

It will not do, then, to rely upon the exaggerated swelling of the periosteum and upon the apparent increase in size of the bone, which is often considerable, and to say that the case is one of periostitis. To do so would be to commit a grave error.

I have referred, in connection with osteitis experimentally produced, to the effect of indirect irritation of the periosteum; and I have mentioned the enormous sub-periosteal ossifications which I had observed in my experiments¹ after irritation of the marrow. Clinical experience furnishes analogous examples every day.

As a result of osteo-myelitis terminating in suppuration and the formation of deep sequestra which remain incarcerated, the tibia or femur may be seen to increase progressively in size and to attain an enormous thickness. There is no more pain, but the source of irritation persists and the plastic periostitis continues. It may in the space of three months, as I have recently seen in the ulna of a patient twelve years old, provoke a sub-periosteal ossification which is double, or more than double, the real diameter of the bone. To penetrate to the medullary canal, I had first to go through a layer of new bone eight millimetres thick, and then through the old diaphysis which

¹ *Traité de la Régénération des Os*, t. i. chap. v.

retained its vitality through the greater part of its thickness, and which was distinguished from the new bone by its whiteness and its compactness.

The peripheral swelling of the bone, that is to say, the sub-periosteal or parosteal infiltration, terminates in various ways; either it undergoes gradual resolution, or it terminates in the production of osteophytes, or it even originates an abscess.

Sub-periosteal abscess, the course of which is very variable and which may occur in the form of either a cold or a phlegmonous abscess, indicates that the inflammation is situated under the periosteum, but it does not indicate that the inflammation has started under this membrane. It may be consecutive to an inflammation of the medulla, as I have already pointed out above, and may be only the last step of a process which has begun in the medulla either of the central canal or of the spongy tissue. If a subperiosteal abscess be limited, if it occupy only a small part of the surface or of one of the faces of the bone, if it be not accompanied by deep, gnawing pain, it may be attributed to a primary periostitis. But if fluctuation appear only at a late period, if it show itself first in the juxta-epiphyseal regions, where communication between the periosteum and the medulla takes place most readily on account of the abundance of vascular openings and the thinness of the compact layer, we should recognize a consecutive periostitis, and should expect to find, not only pus under the periosteum, but also oil-globules, due to transudation of the medullary oil through the canals of Havers.

Suppuration of the bones is seen under various aspects, according to the course and intensity of the inflammation and according to the tissue first affected; it presents also differences fully as important, according to the nature of the affection.

As we are not occupied in this article with either tuberculous or syphilitic lesions of the bones, we may at once eliminate gummata and tuberculous abscesses, which belong to the chronic forms of osteitis, and which have peculiar characteristics: ill-formed pus, grumous, sometimes pitchy, ropy, with or without osseous particles.

In acute or subacute osteitis, the liquid which has been effused under the periosteum, in the periosteal sheath, or even outside of it in the parosteal layers, appears, after rupture of this sheath, sometimes in the form of a clear liquid, only slightly turbid from the presence of white or red corpuscles, sometimes in the form of pus like the laudable pus of a subcutaneous abscess. In either case it may be accompanied by a greater or less quantity of oil-globules. When these oil-globules run together in a serous and almost transparent liquid, they give this liquid the appearance of greasy broth. I long ago explained these varieties in the appearance of the liquids accumulated under the periosteum or in the parosteal layers, and I described in 1872¹ these collections of ropy liquid, transparent as synovial fluid, which are sometimes met with in the inflammations of bone to which I have given the name of albuminous periostitis. I observed this affection for the first time in 1868, in a young patient fifteen years old, affected with osteo-periostitis of the lower extremity of the diaphysis of the femur. A collection had formed above and to the inner side of the knee-joint. It formed a tumor oblong in the direction of the axis of the femur, lifted up the muscular mass, and was the seat of evident fluctuation. The general symptoms which had been troublesome for some days (continuous fever and intense pain) had abated, and even the local heat had almost disappeared. I diagnosticated a sub-periosteal abscess, and made an incision into the tumor with a bistoury. There escaped a gush of clear, ropy liquid like synovia. Those who were

¹ Poncet, De la périostite albuminense (Gazette Hebdomadaire de Médecine et Chirurgie).

present believed that I had opened the joint, but I had done nothing of the kind: the liquid was of bony origin. When I emptied the upper part of the tumor, some oil-globules were seen mingled with the ropy fluid. A stylet introduced into the sac revealed a small extent of denuded bone, a centimetre square at most. After having emptied the sac I closed the little wound by bringing its edges together, and it united. The joint remained untouched, and there was no threat of articular suppuration. The ropy liquid formed again in its periosteal sac, which opened spontaneously some months afterwards. There resulted a small fistulous track which conducted the stylet down to a small denuded portion of the juxta-epiphyseal region of the diaphysis. This portion was cast off afterwards in the shape of a small fragmentary sequestrum, and the suppuration never invaded the synovial membrane, although the nearness of the osteitis had led to a slight propagation of the inflammation to the fibrous tissues of the joint. Flexion of the knee was not complete.

Between the transparent liquid with an albuminous appearance, and opaque creamy pus, all the intermediate forms may be met with; the albuminous liquid is often only the first degree of an inflammation which is going to end in suppuration; but not every sub-periosteal suppuration begins by the accumulation of an albuminous liquid in appreciable quantity. There is often found from the beginning, under the periosteum, pus looking like that which is found in other tissues. It is in liquids rapidly formed under the periosteum, or outside of it, that this serous or albuminous appearance is found. Several times, on opening collections of fluid over bone affected with acute inflammation, with severe febrile phenomena, I have seen, instead of true pus, a sero-sanguinolent fluid, barely rendered turbid by a few leucocytes; and patients themselves sometimes mention, in their recital of their ills, the issue of a watery or slightly sanguinolent fluid.

The presence of oil-globules may be noticed in these different liquids, whatever may be their consistence; but in greater abundance in serous, than in thick and viscous liquids. These oil-globules are due to the transudation of the medullary fat in consequence of increase of intra-osseous pressure and rupture of the fat-vesicles. This transudation is produced experimentally when a stick is driven into the medullary canal of a long bone (Hartmann) immersed in a liquid at the temperature of the body. As the presence of oil-globules is far from constant in osteo-myelitis, the fat being speedily transformed in the inflamed tissues, it must be acknowledged that special physical conditions are necessary, the chief of which seem to be interference with the venous circulation and greater or less friability of the walls of the fat-cells. The conditions differ according as the inflammation comes on suddenly, with all its intensity, in a previously healthy medullary tissue, or as it declares itself in a medulla already influenced by a slight degree of irritation. In the latter case the fat has already gradually disappeared, and the medullary cells are united by an intercellular substance more resistant and less suited to permit the passage of oil-globules through them.

The medullary tissue, contained in an inextensible envelope, whether it be the medulla of the central canal or of the arcolæ of the spongy tissue, is especially disposed to strangulation as soon as it is inflamed. It cannot undergo the increase in size which is caused by hyperæmia and inflammatory proliferation without being exposed to strangulation and mortification. Hence arise the deep and persistent pains which accompany acute or chronic inflammation of the medulla, and which have always attracted the attention of observers. These pains are of different types; they are called osteo-copic pains, and have been particularly described under this name in connection with syphilis; but they are present more or less in all the acute or

subacute forms of osteo-mylitis. They are not found in some forms of tuberculous osteitis, and in neoplastic processes whose course is slow, when absorption of the peripheral bony trabeculae has led to the disappearance of the physical conditions which produce strangulation. I shall return to this subject when speaking of neuralgic osteitis.

Intra-osseous pains often begin with a vague discomfort in the bone, with the sensation of an indefinable *malaise*. The patient complains of weight in the member; he sometimes says that something seems to be gnawing at the bone, sometimes that an enormous weight presses on a limited portion of the limb; at other times he feels a sensation of distention, as if the bone were going to fly in pieces; at other times, finally, it appears as if some one were boring through the bone or hollowing it out. Then there come acute, lacerating pains, which make him cry out, or an insupportable sensation of burning. These pains return every night in the subacute, and in some chronic forms; but in the acute, they are constant during a certain length of time, and have only exacerbations at night. Sometimes, after having lasted eight or ten days, and often more, they cease suddenly. This sudden cessation coincides with the appearance of a larger peripheral swelling, or of an evident sub-periosteal abscess. The appearance of this abscess or of this collection indicates the breaking down of the barriers which held in the inflammation and caused strangulation. This is what is seen in some cases of suppurating synovitis; while the synovial membrane resists, the pains are intense and continuous; as soon as it gives way, inter-muscular sinuses appear, but the compression is at an end and the pain disappears.

DIFFERENT CLINICAL FORMS OF SPONTANEOUS OSTEITIS.

I have already said that nothing is more variable than the clinical forms of osteitis. Although having the same situation, the same extent, and characterized by the same anatomical lesions, these cases present the most varied aspects; sometimes benign, sometimes grave, they are dependent upon the cause which has given rise to them, and to the infecting agent of which they are one of the manifestations.

INFLAMMATION OF BONE ACCOMPANYING THE PERIOD OF GROWTH.—The period of growth of the skeleton being the epoch of life in which most cases of spontaneous osteitis are developed, the name "osteitis of the period of growth" might be applied to the majority of inflammations of the bones which occur in children and adolescents: but, thus understood, the name would not signify anything by itself. We ought to reserve it solely for the osteitis which occurs without an appreciable cause, without any traumatism or local or diathetic source, which appears only associated with an exaggeration of the work of nutrition which is going on at a particular time in any part of the skeleton.

"Growing pains" have always played an important part in the popular theories of children's diseases, but they have not attracted much attention from pathologists, who have been led to deny them, or at least to interpret them differently. In fact, there is nothing so variable as these transient pains of which children complain. It is sometimes hard to locate them, and still more to determine their nature.

Nevertheless pains exist, which are vaguely referred to the joints, but which are really situated in the juxta-epiphyseal region, and which should be attributed to a transient hyperemia of the zone of physiological proliferation. I directed my attention long ago to this point; and I have

been compelled to recognize the good foundation of the popular belief which attributes these pains to growth itself. When children are intelligent enough to give an account of their sensations, they assign these pains to the juxta-epiphyseal regions; sometimes, however, they point out a part of the shaft more or less remote from the epiphyses; and in some cases—in the hip, for instance—they indicate the joint as the seat of pain.

These different seats of pain are explicable by what I have already said about the organs of growth of the bone. If the most active zone of physiological proliferation is found at the juxta-epiphyseal region, it must not be forgotten that under the periosteum, all along the diaphysis, there is a deposit, continuous although unequal in its different parts, of osseous layers for the increase in thickness. On the other hand, there are diaphyseal extremities, that is to say, juxta-epiphyseal regions, which are found included in the joint itself; and the hyperæmic process of which they are the seat may easily be confounded with a pathological process in the articulation; hence arises in these regions, in the hip, for example, an inevitable confusion of osteitis and arthritis.

Growing pains are usually apyretic. In the evening, after having played all day, or having been fatigued in one way or another, the child complains of more or less acute pains in the bones. There is no appreciable heat or swelling; sometimes a little heat. The child goes to bed, and the next day the pains are gone. At other times these pains continue several days, or at least return at different intervals, and then go off as they came. Finally, under other circumstances, the pains invade a number of joints simultaneously, or the same joints in the two limbs, and are accompanied by a more or less marked febrile movement. This transient condition is distinguished from ephemeral fever, with pains in the limbs, by the fact that the pains are here more acute, and that they are fixed in the juxta-epiphyseal parts. The mistaken tendency to attribute to growth the majority of the diseases of children, which prevailed at one time, has brought distrust on the theory of the pains and fever of the growing period. It cannot be denied, however, that these pains exist, with the characteristic of having a juxta-epiphyseal location; but the significance of the febrile movement which often accompanies them might form a subject for long discussion. Is it an independent febrile state, occurring accidentally, and coinciding with an increased growth in the skeleton? Or is it a fever having its source and cause in the organic process which takes place in the zones of growth of the bone?

What gives greater weight to the former theory, is that growing pains are often associated with fatigue, violent exercise, chilling, movements which produce juxta-epiphyseal strain; in a word, with all the causes which, carried a degree further, may produce a true inflammation of the bone. Acting in a slight degree, these causes induce slight hyperæmia, or a few tissue-lesions which are easily reparable; pushed further, and occurring in a subject predisposed to morbid processes by hereditary antecedents or alteration of the general health, they are the commencement of those forms of acute or chronic osteitis which we shall study hereafter.

There is scarcely a child which, in the course of its growth, has not had to complain of these pains, which are most frequently located in the lower limb, particularly above or below the knee; they are observed especially at the time of the sudden advances which occur in the period of growth, and which are evidenced, in some cases, by an increase in height of from twelve to fifteen centimetres a year. While more frequent in the lower limbs, they are also observed in the upper: at the upper extremity of the shaft of the humerus, the lower end of the radius, etc.

But, as I have just said, this exaggeration of the physiological fluxion to

the zone of growth is not always limited to pain, and in many cases it is only the commencement of an inflammatory process which may have very grave consequences. Osteo-myelitis which ultimately assumes an infectious character often commences like growing pains, and parents often mistake the significance of these painful points; they neglect them, let the children walk, and afterwards see the outbreak of graver symptoms.

There is nothing so variable as the onset of these cases of osteitis, unless it be their subsequent course and the consequences which they entail. The grave and acute forms sometimes begin suddenly, with severe local, or with grave general phenomena; but sometimes they are preceded for several weeks by juxta-epiphyseal pains which return in crises, as if by exacerbation, and which pass off spontaneously, leaving only a little torpor in the limb. The pain having passed off, the child resumes his plays, but is easily fatigued, and remains for some time in danger of the most serious lesions.

It is under these circumstances, indeed, that a slight traumatism, a violent movement, a local or general chill (from lying on the grass or the wet ground), brings on the symptoms of acute inflammation, which may soon assume an unfavorable aspect as regards the general health, or may take on a grave character simply in respect to the local phenomena. The same occasional cause then may sometimes provoke an osteitis the gravity of which is proportioned to the severity of the local inflammation, sometimes an osteitis in which the local lesion is lost sight of in the gravity of the general symptoms. Let us endeavor to find the reason for these differences.

INFECTIOUS INFLAMMATIONS OF BONE.—Since Chassaignac, struck with the severity of the general symptoms in acute osteo-myelitis, gave this affection the name of *typhus of the limbs*, all surgeons who have written on inflammation of the bones have made the same observation, and have asked themselves what was the cause of this great gravity. Soon after Chassaignac, Gosselin showed the relation of this form of osteitis to adolescence. Struck with the anatomical disturbances produced at the ends of the long bones, he described the *epiphyseal osteitis of adolescents*, and dwelt upon its gravity.¹ At the same time Klose, of Breslau, described the same affection under the name of *separation of the epiphyses, or meningo-osteo-myelitis*; and various authors (Schutzenberger, Boeckel, Holmes, Giraldués) described it under the name of *phlegmonous or diffuse periostitis*. It has by others been designated as *infectious or malignant periostitis* (Volkmann), as *pseudo-rheumatic inflammation of the bones and joints* (Roser), etc. etc. The names of *acute osteo-myelitis*, *acute osteo-myelitis during growth* (Lannelongue) have also been given to it; Culot called it *acute medullitis*. Since 1860 I have taught the frequency of its juxta-epiphyseal origin, and it was described by Gamet, in 1862, under the name of *juxta-epiphyseal osteo-periostitis*, in accordance with the ideas which I already at that time held in regard to the seat of the primary lesion.

Without discussing the value of these names, which have all some truth in them, and which are applicable to individual cases, we must here study the nature of this acute osteitis, and not seek solely in the localization of the inflammation, the explanation of its gravity. The most important question is this: is the bone-lesion the expression of a general morbid state, of a pre-existing alteration of the blood? or is it the origin, the cause, the point of departure of this condition? The answer to this question is of the greatest importance in regard to treatment; for, as the bone-lesion is the cause or the effect of the morbid state, we should suppress it as soon as possible, or abstain from all interference.

¹ Gosselin, Archives Générales de Médecine, 1858.

As numerous as have been the investigations of this affection during the last thirty years, no approach has yet been made to giving an exact demonstration of the problem. For some years prevailing views have led many observers to seek for a specific microbe. In France, Pasteur; in Germany, Lucke, Recklinghausen, Rosenbach, Kocher, Becker, and others, have published important works on this question. Micrococci have been described which have been regarded as specific; they have been found in the blood, and in the different tissues of the organism; but it has not been possible to cultivate them, or at least to reproduce, by inoculating them, an affection like that which furnished them.

The recognition of these microbes is so difficult, their differential characteristics are so slightly marked, that it would be premature to formulate an opinion from the evidence which we possess at the present time. Becker,¹ however, having injected a culture-fluid into animals in which he had just produced a traumatism of bone, succeeded in multiplying the micrococcus in this new soil, and found it constantly in the blood and pus. Pasteur had announced the analogy of the microbe of osteo-myelitis with that of furuncle. Kocher does not admit any difference between the micrococcus of osteo-myelitis and that which is found in the acute inflammation of wounds. However it may be as to the specific character of these micro-organisms, which we should not yet either reject or adopt, we shall find in our clinical study of the affection strong reasons to admit a primary infection.

In some patients, general phenomena open the scene: intense fever, delirium, and prostration. The case might be thought one of typhoid fever, and this error of diagnosis is so frequent that it is in medical wards that there is most frequently opportunity to observe cases of infectious osteo-myelitis. Sometimes, indeed, the patients succumb so quickly that there is hardly time to suspect the bone-lesion. This lesion is found at the autopsy, but it is of such slight extent that it cannot be considered as the direct cause of death. These cases seem to me to be rare, but they are met with nevertheless. Here is one which I have recently observed:—

A month ago my colleague, Dr. Laure, physician to *La Charité*, communicated to me the notes which he had collected in regard to a child, nine years old, who had died in three days of an infectious osteo-myelitis. Without any known cause, without any appreciable traumatism, this child had been seized with severe fever, delirium, dryness of the tongue, and then profound prostration. Looking for the signs of typhoid fever, M. Laure discovered a little doughiness around the right hip; while any movement of the part made the child cry out. He then diagnosed an infectious osteitis of the hip, and thought of practising resection of the joint. The operation was postponed to the next morning, but in a few hours the child died. At the autopsy, which could not be made complete because of the opposition of the family, there were found in the hip-joint one or two spoonfuls of sero-sanguinolent fluid, slightly purulent. The synovial membrane was slightly injected, but there was no alteration of the head of the femur. At the bottom of the cotyloid cavity, there was a loss of substance a centimetre square, affecting the cartilage covering one of the pieces of bone which form the cavity. At the bottom of this loss of substance of the cartilage, the bone was bare and infiltrated with pus. The corresponding pelvic periosteum was thickened and infiltrated, but there was no sub-periosteal abscess. In the lung there was a small metastatic abscess; on the pleura there were three or four elevations resembling a commencing tuberculous eruption. The pus collected from the denuded portion of bone was inoculated upon two rabbits without result. The pus from the little metastatic focus in the lung was cultivated by M. Chauveau, and inoculated, equally without result, upon other animals.

In cases of this sort we can scarcely consider the bone-lesion as the starting-point and source of the general phenomena. There was an anterior mor-

¹ Becker, *Deutsche med. Wochenschrift*, No. 16, 1863; *Progrès Médical*, 19 Janv. 1884.

bid state which was sufficient, under the influence of a violent movement, a blow, or a fall, to lead to the formation of pus in a part of the bone subjected to a trifling traumatism. But then the traumatism could only be considered as the determining cause of the localization, and not as the origin of the morbid state.

But whence comes this morbid condition? In the majority of septic poisonings we see the door of entrance of the infectious agent; we know the wound which is the starting-point of the pyæmia. But here, in the absence of any wound, we are obliged to seek in the mucous membrane of the lungs or intestines the route by which the infectious germ may have entered. These are questions which are still very obscure, and which would lead us too far if we should attempt to discuss them.

Besides these primary septic intoxications, there are many cases in which, while admitting a general infectious state, a more important part must be assigned to the bone-lesion. If it is the first product of a general infection, it becomes a permanent centre of secondary infection. It is then the starting-point of pyæmic processes, of infectious metastases, which may successively attack various other parts of the skeleton and the different internal organs.

These two modes of infection present very great differences from a practical point of view. In the first case, all surgical intervention is useless; in the second case, on the contrary, suppression of the first focus of infection may, by preventing secondary infection, permit the patient to recover, and thus save his life.

The severity of the primary infection ought to regulate the conduct of the surgeon, and serve as the basis of his prognosis. But in the ignorance in which we are yet as to the nature of the infecting agent and the attenuations of which it is susceptible, we ought always to be very reserved in the presence of osteo-myelitis which is accompanied by typhoid phenomena.

Chassaignac made the prognosis of acute osteo-myelitis very gloomy. He thought that nothing but amputation of the limb could save the patient, and that this was the sole means capable of arresting the consequences. For a long while the majority of surgeons adopted these pessimistic views, and amputation was everywhere recommended. I have long opposed this despairing doctrine, and have shown that the prognosis of acute osteo-myelitis, with typhoid phenomena, is much less grave in the country, in healthy surroundings, than in large hospitals or in the populous and unwholesome quarters of large cities. We receive into hospitals the sequelæ of the infectious osteitis which breaks out in the country, among peasants living in healthy neighborhoods. These are those necroses of the whole or greater part of a diaphysis, for which patients come after some months to ask the assistance of our art. We scarcely ever see necrosis arising in our hospital patients. They are carried off in the course of infectious processes, or they succumb at a later period from chronic septicæmia, if the surgeon does not interfere by amputation or ablation of the bone.

Children or adolescents are sometimes met with who have had at the same time, or near together, five or six attacks of osteitis of large bones of the limbs.

I have, among others, had the care of a patient, who has had acute osteitis seventeen times, either in the juxta-epiphyseal parts of the long bones of the limbs, or in the flat bones (ilium, cranium); he had twice, within a few years, sutural osteitis of the bones of the skull. The majority of his attacks of juxta-epiphyseal osteitis have ended in the separation of small sequestra; he is now completely cured.

Infectious osteitis is seen especially during the period of growth of the

skeleton; but it is sometimes met with after the consolidation of the epiphyses.

Apart from traumatisms, I have seen, in patients of thirty or forty years, a number of cases of suppurating osteo-myelitis of the tibia, humerus, etc., which occurred with the grave phenomena of osteitis of adolescence. In 1865 I resected the lower end of the femur in a man thirty-eight years old, in whom I found the epiphysis detached. The symptoms were ameliorated for several days after the operation, but the patient died on the tenth day from hemorrhage.

Separation of the diaphysis from the epiphysis in adults, although the whole of the connecting cartilage may have disappeared, is made possible by the persistent independence of the lamellar system of the spongy tissue; at any age, up to the most advanced, the trace of the connecting cartilage may be recognized. It is represented by an ossified line, which keeps its direction exactly, and which separates the longitudinal system of lamellæ of the epiphysis from those of the diaphysis. The circulation goes on unequally in these different parts of the bone; the epiphysis is less vascular, while the circulation is more active in the juxta-epiphyseal portion of the shaft. This is what makes the latter region always a seat of election for osteitis even in adults.

We have already seen how much reservation is necessary as to the nature of the agent which produces infectious osteitis, and even as to the mechanism of infection. The study of *post-febrile osteitis* shows, in fact, that there are numerous conditions in which multiple inflammations of the bones may be developed simultaneously or successively under the influence of general infection. All the eruptive fevers—measles, variola, and especially typhoid fever—may be followed by multiple osteitis, which comes on either at the time of evolution of the disease, during convalescence, or some time afterwards.

In these different affections there is an alteration of the blood which, during the period of growth, particularly predisposes to affections of the bones. In all times observers have pointed out the gravity of measles in children in this respect, and many affections of the bones are, in popular theory, referred to attacks of measles or other febrile affections in childhood.

These attacks of post-febrile osteitis differ very much in their course, and are of unequal severity. There are some which are benign; some are sub-acute, and some even chronic; while others are met with which are of the greatest gravity, which progress rapidly, invade successively different bones, and are from the commencement accompanied by septic and pyæmic complications.

This difference in course indicates a difference in nature, and, in certain cases only, an inequality of infection or a greater resistance of the soil in which the morbid germ may have its evolution. The forms of osteitis which are developed in the course of fever and without any appreciable occasion, are those in which infection plays the principal part. Those which occur during convalescence, or after recovery, are often produced by a slight traumatism or by cold. These causes, which would be insufficient in a healthy subject, cause juxta-epiphyseal inflammations in one weakened by disease, who is thereby made to offer less resistance to cold, and in whom, besides, the solidity of the skeleton is diminished, as much by the feebleness of the muscles as by the alteration of nutrition which the bone-tissue has undergone during the febrile period.

During convalescence, a fall, or a violent movement, may produce juxta-epiphyseal strains which cause those forms of chronic osteitis that develop slowly and are afterwards taken for scrofula. The same causes (traumatism, susceptibility to cold), in convalescents, lead to the development of tuberculosis, to which they may be predisposed by their hereditary antecedents. Under

the same conditions, also, tuberculosis may develop rapidly, assume the character of an acute infection, and give rise to a multiple osteitis which progresses rapidly and secretly invades different parts of the skeleton, differing from pseudo-rheumatic infectious osteitis by the absence of acute pain, in spite of suppuration of the juxta-epiphyseal regions. In some cases I have recognized this form of acute tuberculous infection of the bones; in the future it will be advisable, in the diagnosis of cases of this sort, to search not only for the micrococci which are said to be characteristic of infectious osteitis, but also for the bacillus of tuberculosis. Whatever may be the results given by such an examination, which I have not been able to make as yet, because I have not lately had an opportunity to observe favorable cases, the acute and infectious form of osseous tuberculosis should be recognized.

If delayed post-febrile osteitis appears commonly in the subacute or chronic form, that which is contemporaneous with eruptive fevers may also have this character. During an epidemic which prevailed in Lyons, in 1874, I had several times occasion to open collections of pus which had formed in the course of typhoid fever, and which had not given rise to any acute pain. In these cases there was superficial periostitis, and, after the abscess was opened, cicatrization occurred without necrosis following.

In my investigation of juxta-epiphyseal strain¹ I noticed the slight adhesion of the diaphyses to the corresponding connecting cartilages in children who had died of eruptive fevers, and especially of hemorrhagic variola. Separation of the diaphysis took place upon the least effort, and the periosteum was less adherent to the bone than in the normal state. This condition probably exists more or less in all diseases of this category, and may continue for a certain time; this is one cause of the facility with which juxta-epiphyseal strains take place during convalescence from these diseases, and it furnishes an explanation of the chronic osteitis which may develop afterwards.

We know also that in a great number of severe diseases in children a considerable increase in the height of the patient is observed. Repose in the horizontal position and diminution of pressure cannot explain this lengthening of the bones. Auboyer,² who measured many children suffering with acute diseases, found an appreciable increase in height in only eleven out of sixty-two patients. In this connection we must take account of the congested state of the medulla, which has been observed by various observers (Busch, Neumann, Ponfick), and which may at any moment favor the proliferation of the connecting cartilages. Whatever may be the significance of this congested state in regard to growth, it is one of the causes which explain the frequency of juxta-epiphyseal post-febrile osteitis.

From the details which have been given, it is seen that, independent of the resistance of the individual, which cannot be appreciated beforehand, there are different elements which may intervene to explain post-febrile osteitis, and that if infectious agents may produce it, general alteration of the nutrition and the common causes of osteitis play also an important part in its etiology.

RHEUMATIC AND NEURALGIC INFLAMMATIONS OF BONE.—Until recently there has been little disposition to recognize a rheumatic form of osteitis, at least as a distinct affection and determinate morbid process. The articular lesions have masked those of the bone and have caused them to be overlooked. Adams, Cadiat, Ferréol, Gosselin, and others, have corrected this misunderstanding,

¹ De l'entorse juxta-épiphysaire (*Revue Mensuelle de Médecine et de Chirurgie*, 1881).

² Thèse de Lyon, 1881.

and have called attention to rheumatic osteitis. Gosselin¹ has shown that the long bones may be the seat of osteitis of this nature without implication of the terminal joints. Cases of this sort are those which are most convincing, and which ought to settle the question. I have for a long time seen incontestable examples of rheumatic osteitis and osteo-myelitis, and I share entirely the views of Gosselin on the nature of this affection.

Rheumatism of the bones is acute or chronic. The chronic form is the commonest, the acute form is the most serious. For a long time surgeons whose attention has been directed to this matter have been struck with the influence of cold upon inflammations of the bones. It has been noticed that syphilitic osteitis develops itself preferably in the superficial bones which are exposed to cold and external influences. But the analogy between rheumatic fever and the fever which accompanies acute osteitis has been equally noticed. Hence the name *pseudo-rheumatic*, given by Roser to the osteitis which constitutes so much of what is now known under the name of infectious osteitis. I have already spoken of this form of osteitis, and need not here return to it.

The existence of rheumatic osteitis is not to be denied when it occurs in certain circumstances which suffice to determine its nature; when it breaks out, for example, in a patient who has already had one or two attacks of acute or subacute articular rheumatism, and when it manifests itself under the influence of cold, without any traumatism, and especially when it is accompanied by, or follows, inflammation of the fibrous parts of the joints. It is most apt to attack the periosteum, and then it constitutes a superficial inflammation of the bone, which may pass off without leaving any permanent trace, but which sometimes gives rise to sub-periosteal ossifications or to permanent osteophytic excrescences.

Rheumatism may also attack the medulla and give rise to forms of osteitis which are painful, stubborn, and sometimes very hard to cure; but which may rapidly disappear after a certain time. The following is one of the most remarkable examples of rheumatic osteo-myelitis which I have ever had an opportunity to observe, and which have fixed my conviction upon this point:—

A lady, 51 years old, who had had in her youth slight attacks of acute or subacute rheumatism, was caught in the rain on the 7th of December, 1863, and walked for the distance of a kilometre² in the mud and water. She reached her home with her feet soaked. The next day she had swelling and acute pain in the anterior tarsal and tarso-metatarsal joints. For two nights she had a little fever. Eight days afterwards the foot had resumed its normal condition, but she had lancinating pains along the tibia, and especially in the interior of the bone. I saw the patient at this time. There was no perceptible swelling; there could only be felt, especially in the evening, a little heat along the bone. I prescribed blisters, leeches, and Dover's powder. The pains were slightly lessened during several days, but then they came back with greater severity, and, for eight months, in spite of the most active revulsives, they were the despair of the patient, who lost all sleep. At the end of this time the tibia had not undergone any notable increase in size; it had merely a slight arching, and on some days warmth, appreciable to the hand, along the inner face of the bone. At one period the pains assumed such a character that I spoke to the patient about the necessity of trephining the bone. She at this time went to consult Nélaton and Laugier, who diagnosticated an osteo-myelitis, and also spoke of trephining. The patient refused any operation and continued to suffer. She was better and worse for several months, then, in the month of June following, eighteen months after the beginning of the attack, she went to take the waters of Saint-Sauveur in the Pyrenees, and came back completely cured. All

¹ Clinique Chirurgicale de la Charité, 3e édition. Paris, 1878.

² [Nearly five-eighths of a mile.]

the pain in the tibia had disappeared after a few days of treatment, and the patient could walk as before. Suddenly, three months afterwards, in consequence of being chilled, the patient was attacked with an endocarditis which caused such grave valvular lesions that she died the following winter.

In this case, which appeared to me to be typical of rheumatic osteomyelitis, or rather medullitis, it is impossible to mistake the nature of the affection. In young subjects it might be possible to confound rheumatic osteitis with the osteitis of the period of growth. But, as I have already remarked, osteitis of the period of growth does not form a peculiar variety from the etiological point of view. A number of causes may bring it about, or at least provoke it, and in this respect chilling ought to be placed in the first rank. It is in these conditions that I have several times observed aluminous periostitis.

When, as is usually the case, rheumatism attacks the periosteum and fixes itself upon this membrane, it provokes, especially if the patient is young, a more or less pronounced swelling. It also provokes this hyperostosis secondarily when the medullary tissue is first attacked. I have seen a young man of 16 years, whose femur had reached a size apparently double that which was normal, in consequence of an osteomyelitis which had lasted more than a year, and which only yielded to repeated sweatings.

In cases of acute or subacute rheumatic arthritis, a periosteal swelling may be found which extends more or less toward the middle of the bone, and which may give rise to a persistent increase in size or to peri-articular osteophytes.

As all forms of acute osteitis are painful and present characteristic nocturnal pains, that is to say, pains which recur at an almost fixed hour, it may be asked if it be worth while to make a separate category for neuralgic osteitis. All these divisions are doubtless a little artificial. But I shall give with Gosselin the name *neuralgic osteitis* to osteitis in which rebellious pains constitute the predominating characteristic of the affection, and are not accompanied by fever and infectious phenomena. Gosselin has seen it twice in the femur and eight times in the tibia, but has not observed it in other bones. I have seen it, independent of the tibia and femur, which are its most frequent seats, in the humerus, the fibula, the radius, the first phalanx of the thumb, etc.¹ Gosselin, having successfully trephined a number of bones which were the seat of persistent pains, and having found no pus, nevertheless cured his patients. He therefore advises trephining in these cases, which he calls false abscesses of bone. This relief of patients by trephining which has not disclosed any purulent collection, has been observed by a number of surgeons (Nélaton, Barrier), and I myself, in 1862, in the first case of the kind which I had ever seen, caused the pain to disappear, although I found in the centre of the bone only a little semi-transparent, grayish marrow, like a hardened jelly. The pains disappeared for several years, but the process of osteitis was not extinguished; the bone continued to become hyperostosed, and twelve years afterwards the patient was attacked with suppurative panosteitis, which caused his death from pyæmia.

I have several times observed the continuation of this process of hypertrophy in bones which I had trephined for rebellious pains, and in which I had not found pus. A young man whose humerus I trephined twice in 1869, had a considerable hypertrophy of the lower half of that bone in spite of the disappearance of the pains after the operation.

What is the cause of the pains in neuralgic osteitis? The relief afforded by trephining indicates that the cause is compression of the hyperæmic me-

¹ Simon Perret, De la trépanation dans les abcès des os et dans l'ostéite névralgique. Thèse de Paris, 1876.

dulla. By freeing the medullary tissue from its hard and inextensible envelope, and by permitting it, by trephining, to dilate when it becomes the seat of physiological hyperæmia (in walking, in standing, or because of an elevated temperature), we can prevent or put an end to those pains which nothing hitherto has been able to assuage, or at least to make disappear. There are probably two mechanisms which may be invoked to explain these pains: compression of healthy nerve-fibres by the hyperæmic medulla, and compression of nerve-fibres which are themselves already affected with neuritis. But these histological examinations are so difficult and delicate, that I can cite only clinical arguments. In all cases one fact is certain, that is, that these pains cease all the better and sooner, the more completely the medulla is liberated, and the larger and more numerous are the openings in the bony wall.

In searching for the deep collections of chronic osteo-myelitis which keep up those intolerable pains that slowly exhaust the patient, it is sometimes necessary to traverse with the trephine layers of condensing osteitis two or three centimetres thick. The piece removed by the trephine is then white, and dense as ivory. It must not be supposed, however, that neuralgic osteitis is characterized by condensation of the bone-tissue. This condensation is usual around old centres of necrosis; it is also seen in the slow forms of spontaneous or traumatic osteitis; but it is often absent. Sometimes, even, intense and rebellious pains are observed in rarefied, oily, fatty bones, into which the trephine passes easily, and in which neither pus nor sequestrum is found. In a number of such cases which I have seen, the trephine has been the only means of dispelling the pain. Several times, in rarefying osteitis, it has been only after tunnelling the bone (perforating it from side to side) that the pain has completely disappeared.

I have, however, observed some cases of painful osteitis, with nocturnal and stubborn pains, notwithstanding the presence of a small fistulous track which allowed the pus to escape. But in cases of this kind I have been able to put an end to the pains, by substituting for these small openings a large one which prevented any retention. Once only have I observed a rebellious neuralgia in an open abscess. There was a cavity in the juxta-epiphyseal extremity of the radius, into which the probe passed freely by two openings. But simply touching the granulating membrane with the probe provoked acute pain. This membrane was the seat of a true hyperæsthesia. I removed it by enlarging the cavity, and submitted it for histological examination to my colleague, Prof. Renant, who found in it an extraordinary new formation of the fibres of Remak. Except in this one case, I have been unable to assign any cause for the pain except strangulation; in open inflammation of the medulla similar symptoms are not observed.

ABSCESSSES OF BONE.—It is this strangulation which makes acute or chronic abscess of the bones so painful. These abscesses, which have been studied especially since the time of Brodie, are seen principally in the juxta-epiphyseal regions of the long bones, and not in the epiphyses, as might be believed from the expression *epiphyseal abscesses* which was applied to them by E. Cruveilhier. These abscesses are often a more or less remote consequence of osteitis which has suppurated at a previous period. They are explicable by the multiformity of the osteo-myelitis, and by the inequality of inflammation in different parts of the bone. They are often the result of a bi-polar osteitis, one juxta-epiphyseal extremity having suppurated and allowed the elimination of some sequestra, while the other extremity suffered a less degree of inflammation, which did not proceed immediately to necrosis, but which left behind a source of irritation which the usual causes of osteitis rendered active at a later period. Furthermore, these abscesses of bone, consecutive

to osteitis, may be found along the whole length of the diaphysis, the central marrow having been replaced after the first inflammation by a spongy tissue of irregular structure and unequal density.

These secondary effects of osteitis may be observed a long time afterwards. In 1883 I trephined an old man of seventy-five years, who had had an osteomyelitis of the lower half of the tibia at the age of thirteen years, in 1821, that is to say, sixty-two years before. I made two openings with a trephine, and removed the bridge of bone between them with a gouge; and I found in the centre of the bone a collection of pus, in which was a small, longitudinal sequestrum, twenty-six millimetres in length, of compact tissue, which had required more than half a century to become separated and to provoke an appreciable inflammation around itself.

It is easy enough to diagnosticate abscess of bone when it is a remote consequence of osteitis. The persistence of pain, or, at least, its return at the same point, a projection in the bone at this level, persistent heat, and finally a little infiltration and redness of the skin, indicate the formation of pus and its progress toward the exterior. Some of these abscesses take a very long time to appear externally, on account of the thickness of the compact layer which separates them from the periosteum. When, however, there is pus inside the bone, this compact layer becomes medullized by degrees, is vascularized, and finally opens by a spontaneous trephining. But this spontaneous trephining requires months and perhaps years to be completed, if the surgeon does not intervene. The inflammation may cease and the pus be absorbed. This termination is possible in young subjects; and then a circumscribed cyst is formed. But if a new attack of osteitis occurs, the pains reappear, and persist until the opening of the collection, although they may stop again if no sequestrum nor pus has been already formed.

The tolerance of bone-tissue for the products of inflammation, and even of necrosis, is often indefinite in young subjects. There are found in bones formerly diseased, cystic cavities or limited spaces, more or less circumscribed, which are the relics of old osteitis. An aseptic sequestrum may persist indefinitely or disappear by erosion in the midst of medullary granulations. What proves this tolerance of bone-tissue for certain inflammatory products, is the slowness of evolution of some tuberculous and syphilitic collections, which, developed often without pain, persist indefinitely, and are only found accidentally at an autopsy.

These tuberculous collections are liable to inflame suddenly, and then to give rise to symptoms of acute osteitis; but they do not generally have the acuteness of the osteomyelitis of which I have spoken above.

An important point to note in the evolution of these bone-abscesses is that often the pains, which up to a certain time have been very acute, suddenly cease. This is when the pus, by spontaneous trephining from within outwards, has reached the periosteum or is separated from it by only a thin, flexible, and depressible layer. As soon as the sub-periosteal abscess appears, the interosseous pain ceases; and still more if the pus, traversing an erosion or a vascular opening in the periosteum, can spread itself freely in the parosteal layers.

BONE-INFLAMMATIONS FROM THE INTRODUCTION OF POISONOUS INORGANIC SUBSTANCES; PHOSPHORUS-OSTEITIS.—Osteitis produced by phosphorus was a very common affection thirty or forty years ago. Nowadays it is hardly ever seen, at least in France, and in all the countries in which the manufacturers of matches have adopted the use of amorphous phosphorus. At Lyons I saw some cases in the beginning of my practice, but for ten years I have not seen any. This affection was, a few years ago, the subject of numerous works

among which I will mention those of Lorinser, Bibra, Trélat, and Haltenhoff. At first there was some hesitancy in recognizing the special action of phosphorus, and the phenomena were attributed to the impurity of the substance (Dupasquier); but the frequency of cases in match-factories convinced the different observers of the reality of the special action of the phosphorus itself. It was found that the majority of the affected subjects had already caries of the teeth and concomitant alterations of the alveoli; and it was generally believed that the vapors of phosphorus acted on the bone only through the solutions of continuity produced by dental caries and the suppurations to which it gave rise. But Trélat¹ cited four cases in which the teeth were perfectly healthy when the symptoms began, and Haltenhoff reported afterwards² a similar case. Bibra and Geist had previously endeavored to produce this form of necrosis experimentally in animals, and had found, in rabbits which were made to live in an atmosphere filled with the vapor of phosphorus, that necrosis of the jaw-bones occurred only in those whose teeth had been broken or whose maxillary bones had been denuded.

The action of phosphorus shows itself first in one or the other of the maxillary bones; in a single case Lorinser saw it begin in the malar bone. It is seen oftener in the lower than in the upper jaw. According to Trélat, in 167 cases the upper jaw was affected 74 times, and the lower jaw 93 times.

The affection begins with pain in the teeth and a painful swelling of the jaw. Sometimes, according to the observations of Lailler, the bone is swollen before the pains in the teeth attract attention. Then the gums are red and swollen, and the patient notices bloody spitting, etc. Soon the swelling of the jaw increases, and abscesses open upon the gums. The patient is then temporarily relieved; but as the osteitis is eminently progressive, if the patient continues exposed to the vapors of phosphorus, the manifestations only grow worse. The teeth loosen and fall out; the breath is fetid; pus is spit in greater or less abundance; the swelling of the face increases; and the patient presents symptoms varying with the progress of the inflammation to one or another region; the inflammation, starting from the maxillary, is propagated to a neighboring bone (palatine, malar, vomer) and sometimes further—temporal bone (Trélat), occipital (Haltenhoff). This affection is serious because of its spreading course when the patient cannot immediately escape from the cause which has produced it. Nevertheless benign forms have often been observed (Lailler), certain patients, without quitting their work, getting rid of their sequestra as fast as they separated. When the osteitis has attacked a great extent of one of the maxillæ, or several bones at once, it may become of great gravity because of the ceaseless absorption of toxic material which it causes. The patient poisons himself more and more by swallowing pus which is constantly decomposed by contact with the air and by mixture with food. To this poisoning he succumbs in the absence of opportune intervention.

An important question in the study of phosphorus-osteitis, is that of the anatomical lesions which it produces. It has been asked if this osteitis is characterized by special lesions, and if a special anatomical form corresponds to the specific cause which produces it. From what I was able to observe at the time when I saw cases of phosphorus-osteitis, I believe that it has no special anatomical form, and I do not believe that, if confronted with a maxilla which had been removed by resection, or by a sequestrum of the same bone, it would be possible to affirm whether the lesion had been produced by phos-

¹ Nécrose phosphorée (Thèse d'agrégation). Paris, 1857.

² La périostite et la nécrose phosphorique (Thèse). Zurich.

phorus or not. The changes in the bone-tissue, properly so called, and in the periosteal envelope, are in proportion to the progress and degree of the inflammation. I have, in recent years, studied from this point of view all the cases of necrosis of the maxilla which I have seen, and, in the absence of any possible influence of phosphorus, I have seen the different anatomical forms attributed to phosphorus-osteitis, such as periosteal osteophytes, disseminated necrosis, etc.

Besides the removal of the cause which has produced and which maintains it, phosphorus osteitis requires no special treatment. The first thing to do is to remove the carious teeth, to cleanse the mouth with frequent washes, and to remove the patient from all emanations of phosphorus. When once the bone-lesion is freed from these irritating causes, it should be treated like other inflammations of bone, and the surgeon should be guided, especially in pressing cases, by the necessity for freeing the patient as soon as possible from the sources of infection which are introduced by suppuration of the maxilla. The antiseptic indication is the first to be fulfilled, and it is important to have it in view, not only in necrosis of the maxilla, but also in the osteitis which causes this necrosis. Therefore, I do not share at all the view of those who always recommend expectancy in phosphorus-osteitis. As soon as the patient suffers from absorption of pus, the surgeon should intervene, lay bare the parts which supply the pus, and extract them, whether they are necrosed or not. Necrosis is so slow to be limited in phosphorus-osteitis, that irremediable alterations of nutrition would be produced if mobility of the sequestrum were waited for. At the outset it is proper to act as in osteitis which comes on from various causes (cold, traumatism, eruptive fever, state of dyscrasia). These forms of osteitis may be arrested by early incisions or by trephining the bone. The surgeon is guided by the general principles of treatment of osteitis which I shall presently set forth, and which depend upon laying open the periosteum or medulla with the object of preventing necrosis.

When once necrosis has taken place, whether the sequestrum be movable or not, he should intervene by a systematic operation which may permit immediate drying-up of the septic suppuration, the antiseptic indication being the most important. The chances for regeneration of the bone are a matter of less concern in such cases, since the advances of prothetic dentistry permit immediate reparation of the bony deficit. I would add, in regard to regeneration of bone in cases of phosphorus-osteitis, that it does not appear to me that there is anything peculiar in this affection. Cases have been cited in which, in spite of the persistence of the sequestrum, the periosteum has remained flexible and fibrous; and authors have cited others in which a regeneration, sufficient for form and function, has been seen after spontaneous elimination of the necrosed piece. Things go on as in all cases of suppurative periostitis or osteo-myelitis. According as the subperiosteal inflammation has been more or less destructive of the osteogenic layer, according as it has led to more or less rapid separation of the periosteum, the absence of regeneration will be noted, or the presence of a new formation on the deep face of the periosteum, uniting with it and forming the sequestral cavity of the old bone, which is destined to necrose and to be ultimately separated.

For my own part I have had occasion to observe a certain number of old cases of true phosphorus-necrosis, and I have seen the greatest differences in regard to bony regeneration.

In addition to phosphorus, other substances—arsenic, mercury, mother of pearl—have been accused of giving rise to specific inflammations of bone. But the action of these substances is still a matter of dispute, and what there

is of positive in the published observations does not yet suffice to require the recognition of distinct varieties of osteitis.¹

BONE-INFLAMMATION DUE TO THE PRESENCE OF PARASITIC ELEMENTS IN THE PERIOSTEUM AND IN THE OSSEOUS TISSUE ; ACTINOMYCOSIS.—In 1877, a German veterinarian, Bollinger, declared the parasitic nature of certain tumors of the jaw in cattle, which until then had been assigned to osteo-sarcoma, or to chronic osteitis. He discovered in these tumors a peculiar fungus, with a characteristic shape, which Harz designated by the name "*Actinomyces bovis*." This fungus is made up of branching filaments, club-shaped, resting on a pedicle of varying height, and presenting as a whole the appearance of an irregular umbel. Some time before Bollinger, two Italian observers, Perroncito and Rivolta, had discovered parasites in the osteo-sarcoma of cattle (from 1868 to 1873). Their observations remained incomplete, and failed to establish in a precise manner the relation between the parasite and the tumors in which they were found, but it was their observations which first indicated the presence of parasites in the sarcoma of cattle. In man, *actinomyces* was first noted by Israël, of Berlin, and afterwards by Ponfick, of Breslau, and other observers (Fig. 768). As early as 1845, however, Langenbeck had seen at Kiel, in a man who died of cachexia in consequence of vertebral caries, peculiar characteristics of the pus, which he could not at that time interpret as pertaining to a special disease, but which now appear to him to have belonged to actinomycosis.

This affection has not yet been observed in France. For myself, I have never seen it, and all that I shall say about it is only a *résumé* of works published abroad upon the subject.

Since the case of Israël, there have been published twenty-seven cases observed in man.² But in the majority of these, the initial lesion was in the lungs and soft parts. These cases are of only secondary interest from our point of view ; some facts have been observed, however, which ought to be mentioned in connection with osteitis, because the presence of actinomy-

Fig. 768.



Fungus of actinomycosis. On the left is seen the parasite in a state of complete development ; on the right one of the terminal gonidia with a varicose appearance ; on the left, and below, filaments arranged in an umbel ; on the right, and above, an isolated filament with a dentated appearance. (After Ponfick.)

¹ See Art. Syphilis, Vol. II., *supra*.

² Bricon, De l'actinomycose (Progrès Médical, 1881).

cosis characterizes the bone-lesion, establishes its individuality, and determines its nosological position. In a number of cases the lesion has begun as a simple dental caries, but has been followed by abscesses or tumors of the jaw-bone which have necessitated scraping or resection (Partsch). What characterizes the disease microscopically is the presence of small yellowish nodules on the unulcerated tumors. These nodules resemble miliary tubercles. If they are opened, pus escapes which contains yellowish granules, resembling agglomerations of the powder of lycopodium. These granules are sometimes soft, like tallow; sometimes resistant in consequence of calcareous infiltration. They are nothing but colonies of the actinomycetes.

The gravity of this affection depends upon the propagation of the parasite by the channels of the circulation. It invades the lung and then spreads in different regions, and especially in the ribs and spinal column. The commonest lesion is vertebral osteitis. Suppuration of the bones of the limbs has not been observed.

The course of this affection is essentially chronic, although it may give rise to some acute phenomena. The treatment should consist in the extinction or removal of the nests of the parasite. At the beginning, when the parasite is still in the jaw and has not infected the economy, there is a chance to arrest its progress. In one case Partsch practised resection of the maxilla.

Thus far the cases have been too few to make it possible to determine the characteristics which may enable one to diagnose at the beginning the osteitis of actinomycosis; but hereafter, in the presence of chronic suppuration of the maxilla, of the ribs, or of the vertebrae, the pus should always be examined microscopically and searched for the parasites.

The origin of actinomycosis is as yet unknown; it is probable that the fungus is derived from vegetables which both animals and men use for nourishment. Its contagiousness has been demonstrated by Rivolta. Numerous attempts have been made to cultivate the parasite and to study the conditions of its existence and propagation. "The first attempts at inoculation by Peroncito, Harz, and Bollinger, were without result.¹ Ponfick and Zahn were at first no more successful, but Zahn finally reproduced, by inoculation and by insertion under the skin or in the peritoneal cavity, tumors of the same type in two calves and one cow. According to these experiments, the period of incubation varies from 40 to 114 days." Israël has succeeded with dogs.

TREATMENT OF BONE-INFLAMMATIONS.

The treatment of acute inflammations of the bones ought to be conducted on the same general principles that guide us in the treatment of abscesses; in spite of the special indications which their structure suggests, the bones should be treated essentially like the soft parts. When an inflammation commences, we should endeavor to abort it and prevent the formation of pus. When pus has formed, it should be let out as soon as possible by incision of the tissues which retain and imprison it. Whether the pus be under the periosteum or in the medullary canal, it is proper to go down to it, and to give it the freest exit possible.

The treatment of osteitis is first of all subordinated to its nature and degree. There are forms of osteitis which may be arrested at the outset by rest, blood-letting, revulsives, and calomel internally (rheumatic osteitis, osteitis of the growing period, osteitis of traumatic origin). There are others which go on in spite of all the measures which may be employed

¹ Longuet, *L'actinomycose* (Union Médicale, 1884).

(infectious osteitis). We should begin by using local and general antiphlogistics when an acute inflammation attacks one of the bones of the limbs, and especially when it manifests from the beginning a certain degree of acuteness. In adolescents an application of leeches, followed by a purgative dose of calomel and then by mercurial inunctions, will sometimes succeed in removing the evil. But, if pain persists, if fever comes on, if the periosteum and the parosteal layers are the seat of a painful and progressive swelling, and if the terminal joints are threatened, it is necessary to act vigorously and not to rely too much on medical treatment, notwithstanding its frequent efficaciousness in the period of onset.

When remittent intra-osseous pains, with nocturnal exacerbations, are accompanied by fever and general disturbing phenomena, the surgeon must go to meet the inflammatory focus, and not wait until fluctuation indicates the formation of an abscess. He must make an incision down to the bone, through the periosteum, and must do it without hesitation, as soon as the diagnosis of acute osteo-myelitis or periostitis can be made out. The only rule to follow is to intervene as soon as possible by relieving the strangulation of the periosteal sheath, or by trephining the bone, that is to say, relieving the strangulation of the medulla. By acting thus, one may abort threatening inflammations, which by a short delay would have brought on necrosis and would have exposed the patient to pyæmic complications. These free incisions of the periosteum, practised methodically, in case of bones deeply situated and surrounded on all sides by soft parts, constitute a practice which I cannot too strongly recommend, as exploratory incisions in doubtful cases, as liberating incisions in cases in which the violence of the pain indicates strangulation of the inflamed tissues. If exit be given to a clear, ropy, non-purulent fluid, such as is found in the beginning of albuminous periostitis, we should stop at this incision, insert a drainage-tube going down to the bone, and dress the wound antiseptically. If the liquid contain oily drops, if it be clear, we should not go beyond the periosteum; we should wait. The periosteum may become reattached, and the medullary inflammation be resolved. Nevertheless this aggravates the condition, and makes it to be feared that serious manifestations may appear afterwards, due to suppuration of the medulla.

In grave cases one should commence with incisions into the periosteum. Sometimes they suffice to stop the pain and to arrest the symptoms, even when the inflammation is central and evidently of medullary origin. But there are circumstances in which it is necessary to trephine at once, and to open the medullary canal freely; this is when there is already pus in the interior of the bone.

Trephining the bone in osteo-myelitis, which was practised by J. L. Petit and recommended by Van Swieten, was until very recently an exceptional operation. In 1838, Morven Smith published in America a series of cases favorable to trephining in acute osteo-myelitis,¹ but in spite of these examples and the cases of Brodie, Stanley, Nélaton, Gosselin, and Bœckel, this operation was seldom practised.

In 1876, in a memoir read at the Academy of Sciences of Paris,² I called the attention of surgeons to the multiplicity of the indications for trephining in inflammations of the bones, and I recommended this operation in all painful forms of osteo-myelitis. "Trephining the bone," I said, relying upon the results of operations which I had practised since 1861, "is an operation

¹ American Journal of the Medical Sciences.

² De la trépanation dans les diverses formes d'ostéo-myélite (Comptes Rendus de l'Acad. des Sciences, 14 Août, 1876).

applicable to all forms of osteo-myelitis, the predominant characteristic of which is intense and stubborn pain. It is also applicable in some cases to acute osteo-myelitis with grave general symptoms, as a means of aborting the inflammation. These intense and stubborn pains are not peculiar to a single variety of osteo-myelitis. The neuralgic character accompanies the most diverse lesions of the medulla, either apyretic or febrile, and it is the result of strangulation of the inflamed medulla by the bony walls which surround it."

If it is necessary to go in search of the pus, in cases of intra-osseous abscess in which the diagnosis rests upon rational symptoms alone, still more is it proper to give exit to it when incision of the periosteum, permitting examination of the bone, reveals a spongy tissue infiltrated with pus, or when, on the other hand, the signs of retention have not yielded to the periosteal incisions. Trephining the denuded spongy portion is the best way in such cases to put an end to the retention of pus, and to the infectious phenomena of which it is the cause. The diaphysis is sometimes found separated from its connecting cartilage, and pus accumulated between this cartilage and the layer of spongy tissue which is next to it. This is what is seen in juxta-epiphyseal osteitis which has begun exactly at the junction of the diaphysis and the cartilage. But, in spite of this separation, the opening of the purulent collection will not suffice to put an end to the strangulation of the medullary tissue. The pus cannot flow freely, and the medullary cells must be opened through a certain extent to facilitate its escape; and if there is separation of the periosteum higher up, corresponding to already necrosed portions of the diaphyseal sheath, the trephine should be used at this point in order to penetrate to the central canal of the bone.

When the surgeon then intervenes at the outset, he may be content with opening the periosteum freely; but he must not hesitate to go even to the medulla, if infiltration of the spongy tissue, and a gray, dull, non-vascular appearance of the compact tissue, bathed in pus, indicate necrosis of the diaphysis. In such a case pus will be found in the medullary canal, and its evacuation will be the only means of bringing to an end the phenomena of infection, and of preventing more extensive necrosis. In a word, it is necessary always to be guided by this idea, that the bone-tissue must be treated like the soft tissues, and to penetrate to every point where pus may be suspected to be shut up. One opening with the trephine will not be enough in central osteo-myelitis of the large bones of the limbs; several must be made along the bone; and, if the arrangement of the parts permit, the bone should be perforated from side to side, so as to prevent all stagnation of the pus.

These trephinings do not cause necrosis; on the contrary, they constitute the best means of preventing or limiting it, and may obviate the necessity for total extirpation of the bone, or for amputation of the limb.

Chassaignac, as I have already mentioned, extolled amputation of the limb as the only rational mode of treatment in acute suppurative osteo-myelitis. For a long time these ideas were dominant in science, and they have had too many advocates among surgeons. Amputation appeared to them, indeed, the best means to rescue the patient immediately and definitively from the pyæmic infection which threatened him. And yet, formerly at least, the successes of amputation practised when the symptoms were acute, were very rare.

At the beginning of my practice, when I had not the same confidence that I have to-day in trephining or in simple ablation of the diseased bone, I did a certain number of amputations of this sort, and I saw almost all of my patients perish, either from a continuation of the original infection, or from pyæmia resulting from the amputation. In these cases the patients are espe-

cially predisposed to this affection, and they often succumb to true pyæmia, whether subjected to amputation or treated by incision of the abscess.

Nowadays amputation should be but rarely practised; trephining or total ablation of the diseased bone will save limbs which formerly were sacrificed. Everything depends upon the extent of the lesion, and upon the number of joints invaded; if several bones are attacked, with their contiguous joints, in different segments of the same limb; if the multiple joints of the foot and of the hand are invaded at the same time as those of the elbow and knee, or if, on the other hand, the soft parts are so burrowed by the purulent deposits that the limb resembles a sac full of pus, amputation becomes necessary. But if a single one of the large bones of the limbs be attacked, even if it be affected with panosteitis, that is to say, with total inflammation of the bone, and suppuration of the terminal joints, it may be removed. For, by practising this operation by the subperiosteal method, an operation will be done which is not usually graver than an amputation. Much more, if a pandiaphysitis be met with, which has left intact the terminal joints, one should save the limb and put a stop to infection by total ablation of the infecting centre, that is to say, by ablation of the portion of bone of which the medulla is infiltrated with pus.

Sub-periosteal ablation of an inflamed bone, done before the diffusion of the pus through the soft parts, will doubtless always be a serious operation; but with antiseptic dressings it should be attempted much oftener than in the past, especially with children in whom we may hope for regeneration of the bone from the periosteum which has been saved. In the adult, amputation offers greater advantages.

I can give here only general rules. Everything depends upon the importance of the diseased bone, and upon the orthopædic or functional result which may be obtained by saving it. Total ablation of a femur or of a humerus ought never to be undertaken except after failure of multiplied trephining of the bone, or when the sub-periosteal and intra-medullary lesions are such that the whole of the bone is certainly destined to necrosis. And even in the latter case, one ought to try first to put an end to the septic complications by local disinfection, by means of chloride of zinc or other metallic salts suited for coagulating the contents of the medullary canal, or for preventing all subsequent decomposition. By permitting the bone thus rendered aseptic to detach itself, its regeneration is better provided for than by removing it at once. It is very rare to have to remove the whole of a bone. Usually when both terminal joints are affected, the infectious state is so well marked that it contra-indicates any operation. Bockenheimer¹ successfully removed the whole of the femur from one joint to the other. I have never had occasion to do an operation like this. The cases to which the method of sub-periosteal extraction is specially applicable are those in which a part of the diaphysis is affected, with one of the corresponding epiphyses; that is to say, the cases in which there is suppuration of one articulation, and in which this is accompanied by osteo-myelitis of a greater or less length of the bone.

When inflammation has started in an epiphysis, it remains limited to it for some time, or else speedily invades the corresponding joint, according to the relations of the particular epiphysis with the articular cavity. There are some epiphyseal inflammations which cannot exist without concomitant arthritis, as in the head of the femur or radius; there are others which may remain some time without provoking arthritis, as in the lower end of the femur, the epiphyses of the tibia, etc.; these epiphyses are partly extra-synovial and partly intra-synovial. According as the inflammation begins

¹ Deutsch. med. Wochenschrift, Nos. 50 und 51, 1878.

in one or the other of these parts, the joint remains unattacked for a longer or shorter time. When once the articulation is invaded by pus, epiphysitis can scarcely be cured except by resection.

Juxta-epiphyseal inflammations themselves are subject to the same considerations. Certain juxta-epiphyseal extremities are either altogether intra-synovial, as the neck of the femur, or partly so, as the upper end of the forearm; hence the necessity for resection of the joint when suppuration invades them.

As suppuration of the joints singularly aggravates the prognosis of osteitis, it is necessary to make every effort to prevent it. The best means of doing this is to interfere early, and to try to arrest the osteitis by making free incisions in the periosteum and by trephining into the medulla. If there are infecting forms which progress with a rapidity which overturns all our calculations, the majority of osteo-myelitic inflammations do not immediately invade the whole of the bone, and there is time for intervention. I recommend all the more urgently early interference, because nowadays, with antiseptic dressings, an exploratory incision, made methodically down to the periosteum, is applicable to the majority of cases of osteitis. When once the diagnosis of osteitis is established, it is not possible to interfere too soon in the acute forms. To wait for suppuration, as there is too much tendency to do in accordance with the old ideas, is to expose the patient to all the infective complications of medullary suppuration, and to invasion of the neighboring joints.

We should not wait for suppuration, we should anticipate it. We should, I repeat, decide all the more promptly to intervene since pyæmia is no longer as it was formerly, before the era of antiseptic dressings, the result of laying bare the medullary tissue. We should especially decide to act quickly in cases of old, recurrent osteitis, when local heat, violent pain, and fever, indicate a return of the osseous inflammation. Trephining at the painful point will arrest both the patient's pain and the accompanying symptoms.

It is not possible to attach too much importance to these remains of acute osteitis, which are always ready to become the point of departure of a new outbreak, and which are seen especially in subjects whose osteitis has been cured, or has seemed to be cured, the first time, by spontaneous trephining or by the discharge of a few small sequestra. There are cases of this sort which are never definitively cured until one decides to scoop out large channels along the whole length of the bone, from one extremity of the diaphysis to the other. If the openings are made too economically, centres of osteo-myelitis are left, with or without vascular sequestra, which will show themselves at a later period under the influence of fatigue or cold, and which will necessitate a new intervention. Trephining, or, in other terms, scooping out large openings which penetrate into the bone, is most frequently done without the assistance of the ordinary trephine, in osteitis of the spongy tissue. The cutting gouge, that is to say, a gouge cutting on its lateral borders, suffices for excavating the necessary channels in inflamed spongy bones. Further choice of the necessary instrument may be guided by the shape, the thickness, and the hardness of the bone. The small trephines which Laugier long ago employed for blood-letting from the bones, are often very useful in central osteitis as exploratory instruments, to ascertain the contents of deep collections.

INFLUENCE OF OSSEOUS INFLAMMATIONS ON THE GROWTH OF BONES.

Certain changes of form and volume which the bones may undergo in acute or chronic inflammation, have long been recognized; but it is only recently that search has been made for the cause of these changes, and that the question has been asked why inflamed bones remain shorter than their congeners in some cases, and under other circumstances assume larger proportions. My experimental researches, while enabling me to determine the laws of physiological growth, have also demonstrated the laws of pathological growth; and we are able to-day, by studying the seat and duration of inflammation, to know beforehand what disturbance it will bring to the development of the organ.

Every persistent irritation of a diaphysis, whether periosteal or medullary, is manifested in a young patient by an exaggerated growth of the part. The bone is more or less hypertrophied, that is to say, increased in length and thickness, whenever the irritation has been intense enough to propagate itself gradually to the periphery and to the extremities of the diaphysis, without however causing destructive suppuration. When a bone is irritated by lacerating the periosteum, by breaking up the medulla, or by introducing foreign bodies into it, there is soon observed sub-periosteal hyperplasia associated with abnormal lengthening. When a bone is denuded of its periosteum, this bone does not increase in thickness, because the elements of increase in this direction have been removed; but it increases in length.¹ This increase in length is not due to interstitial growth; it is due to hyperplasia of the connecting cartilage, the cellular elements of which have become more prolific. To demonstrate this, it is only necessary to fix pegs at certain distances from each other, in the diaphysis and the terminal epiphyses, and to cause in any way, independently of the action of the pegs, a continuous irritation of the bone. It will then be seen that the pegs in the diaphysis have not changed their relations to one another, but that the pegs in the epiphyses have been respectively separated from the nearest peg in the diaphysis. The excess in length is produced at the position of the connecting cartilage, and by its means; for if it be excised, the growth of the bone will be cut short.

It will not do, however, to absolutely deny the occurrence of interstitial growth in inflamed bones. I have seen, rarely it is true, but I have seen, nevertheless, a little growth in inflamed bones in adults; and Poncet has mentioned a lengthening of fifteen millimetres in the humerus of a syphilitic woman. But this lengthening is so slightly marked that it may be neglected in the majority of cases.

Inflamed bones in the adult may acquire greater thickness, by means of the newly formed subperiosteal layers which may be deposited at any age under the influence of irritation of the periosteum. But when once the connecting cartilages are ossified, they cannot increase in length, unless in exceptional cases in which the bone-tissue has changed in structure and in consistence under the influence of slow and chronic inflammation.

Inflammation of the periosteum and medulla is propagated to a distance; and when it attacks the connecting cartilage it excites greater and more prolific activity of its cells. But if this transmitted irritation, which I call "indirect irritation," is productive in the matter of growth, the same is not true in regard to direct irritation, or irritation acting directly upon the tissue itself. This kind of irritation, instead of increasing the activity of growth in the bone, and the formation of bone-tissue by the cartilage, produces

¹ *Traité Expérimental et Clinique de la Régénération des Os*, t. i. ch. v. et xii.

an opposite effect. It disturbs the process of ossification, sometimes hastening, but oftener retarding it. In every case it has the effect of diminishing the production of bone. In consequence of crushings or of multiplied incisions of the cartilage, there are formed cicatrices in the middle of the cartilaginous tissue, which remain fibrous for a greater or less time, and which hinder the evolution of the series of cartilaginous cavities which remain healthy. It is only in case this direct irritation is slight and not destructive, that it has no unfavorable influence. If the irritation be intense, if it go on to partial destruction of the connecting cartilage, then it causes an arrest of growth proportional to the number of cells destroyed. This is what happens in osteitis which is developed exactly in the position of the cartilage, and which always alters its tissue more or less. In some cases the inflammation passes into the epiphysis, going through the cartilage, which becomes necrosed; and then the result is an almost absolute arrest of growth.

From this it is seen that the seat of inflammation in a bone explains the apparently contradictory effects of osteitis upon its growth. An inflammation seated in the centre of the diaphysis, or even in the spongy part of the bone, but far enough from the cartilage not to bring about its separation by pus, and still more its destruction, will be followed by lengthening of the bone. An inflammation, on the contrary, situated at the limits of the cartilage, which brings about partial or complete destruction of the normal spongy layer, or even of the whole thickness of the cartilage, by disintegration or by necrosis, will be followed by more or less marked arrest of its growth in length.

The excess of growth in bones affected with spontaneous or traumatic osteitis, may amount to seven or eight centimetres in a bone like the tibia. Usually the difference is less, lengthenings of two or three centimetres being the most common. These are observed in adolescents who suffer from a persisting remnant of an osteitis which has occurred some years before. Persistence of a sequestrum incarcerated in the centre of the diaphysis, or of a simple patch of osteo-myelitis, is enough to produce it, although the patient no longer suffers pain, or at least acute pain. A slow and silent work is going on which produces its effect upon the zone of physiological proliferation, and which finally betrays itself by an increase in length and thickness.

Hypertrophy in length does not take place equally in all cases of osteitis. It varies with the end of the bone attacked by inflammation. I showed, in 1861, that bones did not grow equally at their two ends. There is in each bone one extremity which contributes more than the other to the increase in length. By inserting leaden nails in the different bones of young animals, I found that this inequality of increase at the two ends began at birth and continued during the whole period of growth. It was not due then to the different epochs for union of the epiphyses, as might have been supposed. The difference in the time of union of the epiphyses is of little importance in explaining the inequality of growth. The earliest union does not take place until growth is about to cease, and the continuation of growth by the remaining cartilage is, on that account, of little importance.

In reality, there is a great difference between the two extremities in regard to growth; and, without being able to formulate it precisely for man, it may be said that in certain bones, as the radius and ulna, for example, increase is at least four times as great at the lower as at the upper end. In the femur, growth at the lower end is about three times as great as that at the upper end, after the age of four years.

My experiments have led me to the following conclusions in regard to the growth of the large bones of the limbs:—

In the same limb, the bones of the principal segments are in an inverse relation, and when the upper and lower limbs are compared, the analogous bones are in an inverse relation to each other. In the upper limb, the humerus grows in an opposite manner to that of the radius and ulna. The former grows most markedly from above; the latter especially from below. While the humerus grows principally from above, the femur, which is its analogue in the lower limb, grows chiefly from below. The radius and the ulna grow chiefly from below, while the tibia and fibula grow a little more from above.

From this a formula may be derived for the large long bones of the limbs.

In the upper limb, in the bones of the arm and forearm, the extremities distant from the elbow grow the most.

In the lower limb, in the bones of the thigh and leg, the extremities at a distance from the knee grow the least.

The relation which I have already noted between the activity of physiological growth and the frequency of neoplastic processes, should lead us to study the influence which may be exerted by inequality of growth in the two extremities of the bone upon the seat of election of such processes. Long ago¹ I showed that the end of a bone which takes the most active part in its growth, is also the seat of election for neoplastic lesions, such as benign or malignant tumors. The same relation exists with regard to inflammatory lesions, but it is much less striking. The rule seems even to have quite a number of exceptions. This depends upon the fact that inflammations of the bones are often caused by cold, and especially by traumatisms, such as juxta-epiphyseal strains, repeated frictions, and contusions of the bones, and that these latter causes act more especially in certain regions, such as the knee and the ankle, so as to set up inflammation exclusive of any special predisposition. Here, moreover, are some statistics which show what relations exist between the law of growth of the long bones of the limbs and the seat of neoplastic and inflammatory lesions.

In by far the greater number of cases neoplastic lesions are situated in the extremity of election for growth in length. In fifty-six cases which I have gathered at random, as they came under my notice, I have found the following proportions for the seat of neoplasms in the large bones of the limbs:—

Femur,	24 cases	.	.	.	.	{	Upper third	.	.	3
						{	Middle third	.	.	2
						{	Lower third	.	.	19
Tibia and fibula,	16 "	.	.	.	.	{	Upper third	.	.	10
						{	Middle third	.	.	3
						{	Lower third	.	.	3
Humerus,	10 "	.	.	.	.	{	Upper third	.	.	7
						{	Middle third	.	.	2
						{	Lower third	.	.	1
Radius,	4 "	.	.	.	.	{	Upper third	.	.	0
Ulna,	2 "	.	.	.	.	{	Lower third	.	.	6

The seat of election for these tumors corresponds, then, exactly with the seat of election for increase in length; they are the lower end of the femur, the upper end of the tibia and fibula, the upper end of the humerus, and the lower end of the radius and ulna.

The same relation exists for spontaneous osteitis, but it is not so striking; because, as I have said, the frequency of occasional causes of osteitis in certain regions counter-balances physiological predisposition. Repeated traumatisms and the action of cold will set up inflammation preferably in that

¹ Mémoires de la Société des Sciences Médicales de Lyon, 1863.

part of the bone which is least active in growth, if the region of election for growth is by its situation less exposed to the influence of those causes.

The lower end of the femur is the seat of osteitis much oftener than the upper end; this corresponds with the law of growth. But in the tibia and fibula the case is different; the figures are about equal (40 to 42) in the tibia, with a slight advantage in favor of the lower end. It is true that growth, although more marked at the upper end, probably does not much exceed, in man, that which takes place at the lower end. In the fibula the exception is more striking, for the lower end was much oftener the seat of osteitis in the series of cases which I have examined.

In the upper limb more numerous exceptions are found. In the humerus the upper extremity was attacked 13 times, while the lower extremity is noted 12 times. This is very little more at the upper extremity; and yet, according to my calculations, which, it is true, are only approximative in regard to man, growth from above is four times greater than growth from below; but the fact that the elbow is more exposed to blows and to cold, changes this relation by increasing the importance of the occasional and determining causes. The radius and ulna, which are much more frequently attacked at their lower end, show better the difference which might *a priori* be expected on account of the marked predominance of growth at the lower extremity.

Spontaneous osteitis is much more frequent in cold and wet countries. It is hard to say in what proportions; for hospitals, where a large number of these cases are seen, receive them from all quarters, and statistics permit only approximative calculations. At any rate, this affection is more common in the north than in the south.

By analyzing 305 reports of cases of osteitis collected in my service at the Hôtel-Dieu, M. Mondan, Chief of the Clinique, obtained the following particulars in regard to the age of patients suffering from osteitis:—

The disease began:

Under 10 years	37 times.
Between 10 and 20 years	166 “
“ 20 and 30 years	51 “
“ 30 and 40 years	16 “
“ 40 and 50 years	10 “
Above 50 years	7 “
Age not mentioned	25 “
Total	312 “

This table shows the frequency of osteitis between 10 and 20 years, but might lead to error in regard to the number of cases of osteitis below 10 years. I ought to point out that the proportion changes in hospitals in which patients of all ages are received indiscriminately. At the Hôtel-Dieu of Lyons, it is exceptional to receive a patient less than 12 years old; on account of which a large class of patients is omitted from our calculations. Still more does this proportion differ for the early ages in hospitals, in which only children below 15 years are received.

Lannelongue gives the following figures:—¹

Under the age of 5 years	9 cases.
From 5 to 10 years	17 “
From 10 to 15 “	41 “
From 15 to 20 “	30 “
1 case 21 years, 1 case 22, 1 not indicated,	3 “
Total	100 “

¹ Ostéo-myélite pendant la Croissance.

In regard to the seat of osteitis, an analysis of the cases gathered in my service at the Hôtel-Dieu gives the following figures for the large bones of the limbs:—

Femur	{ Upper third	22	} 95
	{ Middle third	15	
	{ Lower third	58	
Tibia	{ Upper third	40	} 124
	{ Middle third	42	
	{ Lower third	42	
Fibula	{ Upper third	5	} 18
	{ Middle third	2	
	{ Lower third	11	
Humerus	{ Upper third	13	} 30
	{ Middle third	5	
	{ Lower third	12	
Radius	{ Upper third	1	} 11
	{ Middle third	3	
	{ Lower third	7	
Ulna	{ Upper third	4	} 13
	{ Middle third	2	
	{ Lower third	7	
Total	291	

In the statistics of Sézary the different bones were affected in the following order:—

Tibia	56 times.
Femur	47 “
Humerus	10 “
Fibula	3 “
Radius	2 “
Ulna	1 “
Total	119

Lannelongue reached the following results:—

Femur	34 times.
Tibia	23 “
Fibula	2 “
Humerus	5 “
Radius	2 “
Total	66

In regard to sex, I find in my own observations, among 294 cases of osteitis:—

Females	47
Males	247
Total	294

This proportion of osteitis in men and women does not seem to me to be exact; the ratio of 1 to 5.2 is too small. That it should appear in my statistics, is explained by the fact that for three years my service did not include women. I should think it to be really about 1 to 3. At any rate, osteitis is much more common in males than in females.

Osseous inflammations produce disturbances in the growth of bones not only by exaggerating or repressing their development, but also by causing curvatures, deviations, and flexions, which may be very annoying from a functional, and moreover very disfiguring from an æsthetic point of view.

Juxta-epiphyseal osteitis causes loosening of the diaphysis, which leaves for a while a little mobility between the diaphysis and the epiphysis. At a certain time there is at this point a sort of articulation, an amphiarthrosis,

Fig. 769.



Separation of the upper juxta-epiphyseal extremity of the diaphysis of the tibia from the corresponding epiphysis. Inclination of the leg inwards.

which does not permit extensive motion, but which permits the separated parts to slide one upon another, either under the influence of the weight of the body, or under the influence of muscular contractions.

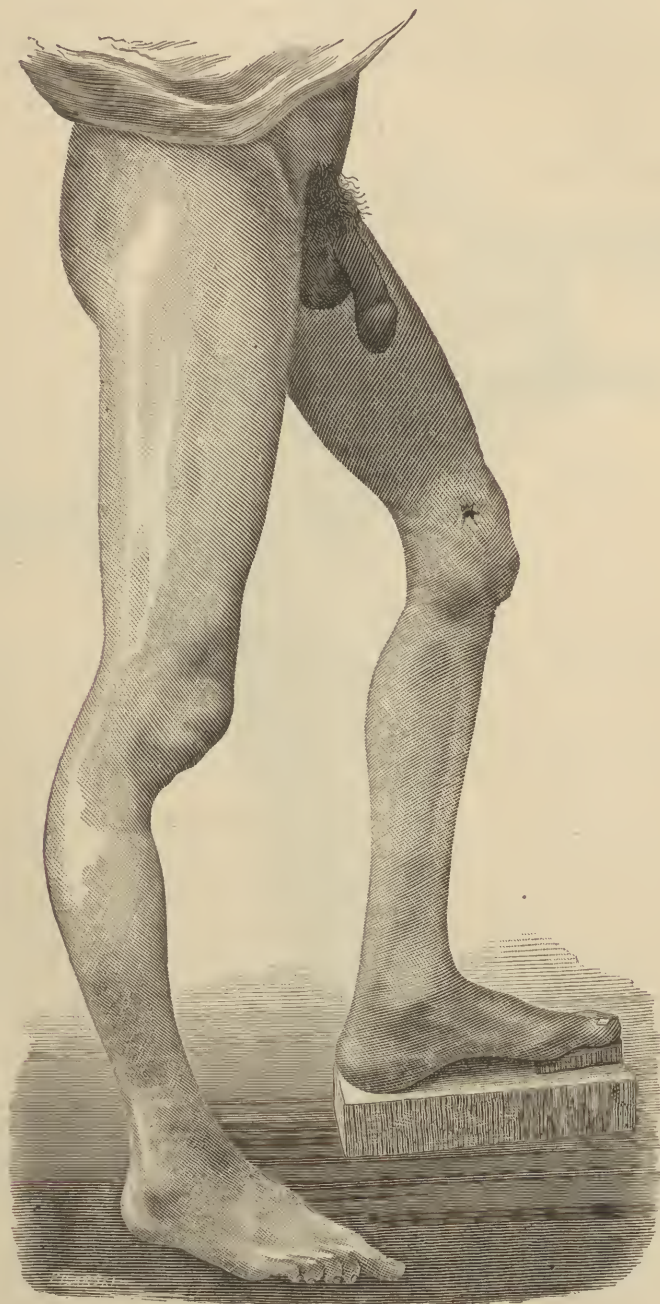
This mobility persists as long as the periosteal sheath is not ossified and preserves a certain degree of flexibility. For this reason its duration is very variable. In some cases, when there is only a little suppuration, limited to one point, and medullization or rarefaction of the rest of the surface of the bone, the mobility is scarcely appreciable, and very transient. But when the end of the diaphysis is bathed in pus, and necrosis extends for a considerable distance, the abundance of the suppuration retards the plastic process, and the periosteal sheath remains a long time flexible and movable. The separated diaphysis may then be dragged in one direction by muscular contraction, and the necrosed extremity, which presses against the periosteal sheath, finally perforates it, and may even protrude under the skin. These displacements vary for each bone. I give here some illustrations:—

Here, first, is a separation of the upper end of the diaphysis of the tibia (Fig. 769). The epiphysis has preserved its relation to the femur; the knee-joint is intact; but the diaphysis is displaced upon the epiphysis, and instead of being in the axis of the femur, it is inclined inwards. At first sight, it might be called a *genu-varum*; but, as I have just said, the knee is intact. In this case the necrosis lasted about two months, and some pieces of necrosed spongy tissue were eliminated. The limb may be partly brought back to its normal position and may become consolidated.

Among the cases which I have seen, I will mention the following, which involves both lower limbs, and which presents a forward deviation of the diaphysis of the femur, and a backward deviation of that of the tibia (Fig. 770). Above the patella on the left side a second prominence is seen, as marked as that of the patella itself. This form is characteristic; and constitutes what I have designated under the name of double-knee. The epiphysis has been drawn backwards by the muscles which flex the leg upon the thigh, while the periosteal sheath has been still pliable; for, from this there has resulted an anterior projection, formed by the lower extremity of the dia-

physis. Here it is the epiphysis which is displaced upon the diaphysis. In the tibia, the upper epiphysis has not moved at all, held back as it has been by the ligaments and the capsule of the joint, but the diaphysis has been

Fig. 770.

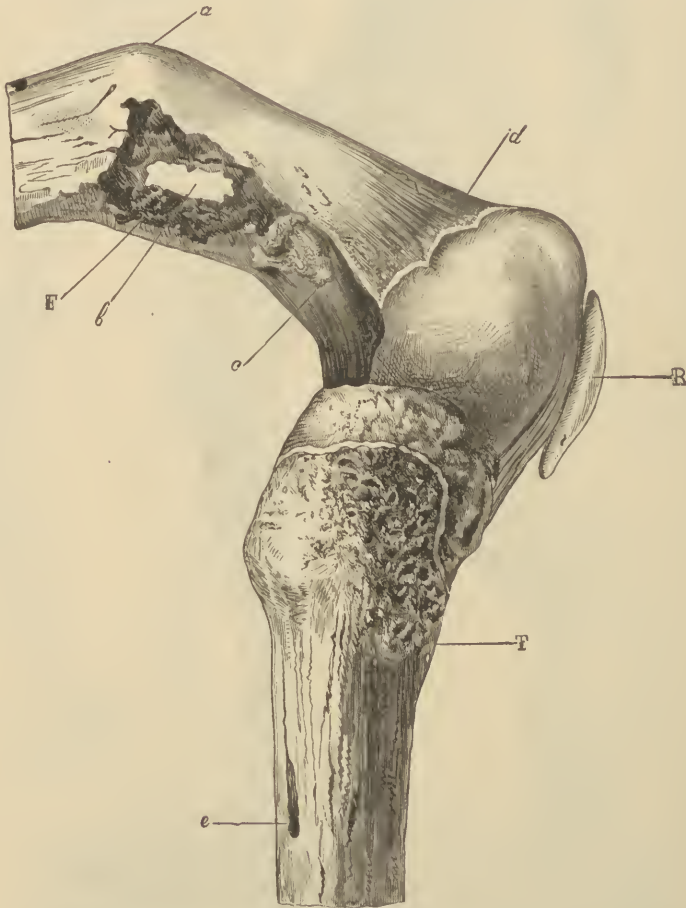


Double diaphyseal separation in the same patient, in consequence of juxta-epiphyseal osteitis: lower epiphysis of the left femur; upper epiphysis of the right tibia.

carried backwards. This deviation commenced while the patient still kept his bed, and it only became more pronounced when he began to walk.

I give here two drawings which will enable us to interpret the preceding cut (Fig. 770), which represents a patient who was under my care in 1868, and who recovered completely. Some time afterwards, in 1869, being in Berlin, I saw in Wilms's collection two anatomical specimens, of which he was kind enough to permit me to make a sketch, and which illustrate exactly the same lesion. They were specimens coming from patients whose thighs he had amputated. The first (Fig. 771) shows a curvature of the femur in the

Fig. 771.

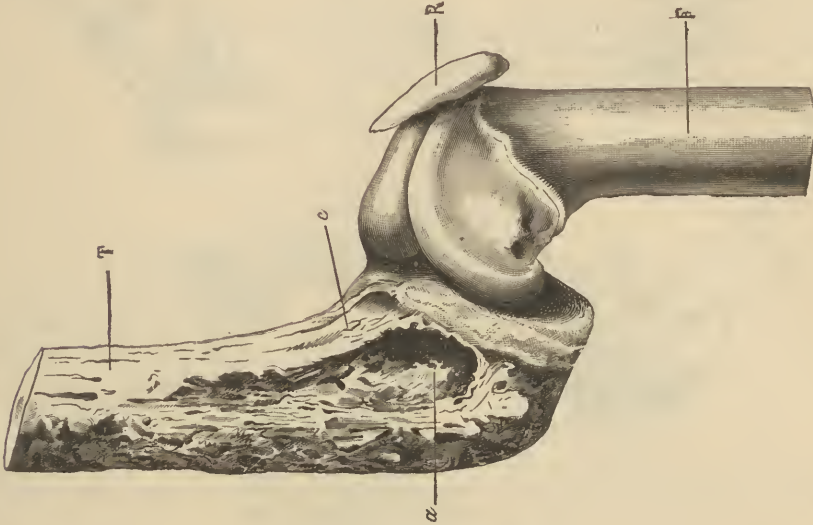


F, femur; T, tibia; P, patella; a, angle formed by the meeting of the portion of the bone a d, developed since the beginning of the osteitis, with the old diaphysis. The connecting cartilage has become more and more distant from the diaphysis as it has furnished new layers of bone. This new portion of bone became bent upon the old portion while it was still but slightly rigid, being drawn backward by the flexor muscles. b, perforation through which a sequestrum has escaped.

lower juxta-epiphyseal region. The patient had had a juxta-epiphyseal osteitis ending in necrosis. The sequestrum had protruded gradually through the opening B, and had been extracted. Inflammation propagated to the 'knee-joint' had necessitated amputation through the thigh. In this specimen,

it is seen that all the portion of the diaphysis formed since the osteitis, and comprised between the end of the diaphysis indicated by the prominence *a* and the connecting cartilage *d*, had from the beginning been drawn backward by muscular contraction. The result of this was a change of direction in the new portion, and the prominence which no doubt gave the limb the appearance of double-knee. Fig. 772 shows a bending forward of the dia-

Fig. 772.



F, femur; R, patella; T, tibia. The tibia presents a flexion forwards of the diaphysis upon the epiphysis, which is itself slightly luxated behind the femur. A, juxta-epiphyseal sequestal cavity; B, epiphysis; C, diaphysis; D, angle pointing backwards, indicating the displacement of the diaphysis upon the epiphysis.

physis of the tibia upon its upper epiphysis. There is a re-entrant angle in front and a projection behind. This is the same lesion as in the preceding figure.

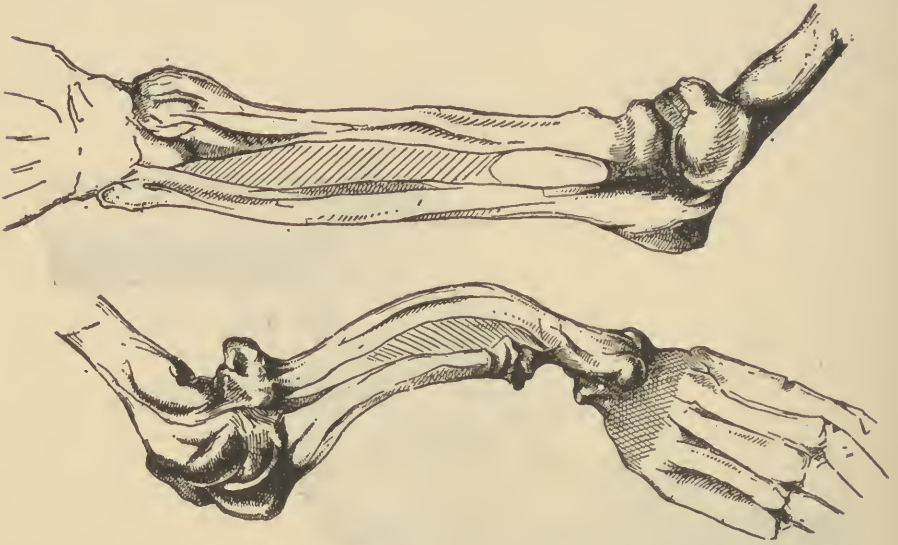
When inflammation attacks one bone of a limb-segment with parallel bones, like the leg or forearm, various deformities result, which are explicable either by the arrest of development in one of the bones, or by its excessive development. In the forearm, for example, when the radius is arrested in its development by an inflammation which destroys the lower connecting cartilage, the ulna, continuing to grow and being held back by its attachment at both ends to the radius, is forced to curve or to twist. The two epiphyses are almost fixed, since they are united to the radius which does not grow any more; and the diaphysis, which continues to elongate by ossification of the layers furnished by the connecting cartilages, necessarily takes a sinuous shape. I have shown experimentally¹ these different effects of arrest of growth in one of the bones of the leg or forearm, and I have, by partial excision of the connecting cartilages, reproduced all the deviations which are seen in man in consequence of the forms of osteitis which cause destruction of the connecting cartilages in childhood. In this way the knees may be made to deviate inward or outward, as well as the front and back feet.² These experiments led me further to practise excision of the con-

¹ *Traité Expérimental et Clinique de la Régénération des Os.*

² *De l'Accroissement Normal et Pathologique des Os.* 1872.

necting cartilages with a surgical object; that is to say, to correct deformities due to inequality of growth in parallel bones.¹ On the other hand, I have indicated the means of increasing in man the normal growth of bones, by

Fig. 773.



Arrest of development of ulna as the result of juxta-epiphyseal osteitis. The radius having continued to grow is curved upon itself. (After Poncet.)

permanent irritation of the diaphysis during the period of growth of the skeleton. Antiseptic methods will make it possible in future to have recourse without danger to these operations for the correction of deformities, which were formerly dangerous on account of the intra-medullary suppuration which they might produce when more than the superficial layers of the bone were implicated.

I have already spoken of the relation of osteitis to the seat of election for growth in the large bones of the limbs. I ought, before going further, to speak of this more fully, and to show that it is applicable to all the bones, whatever may be their shape. In all the flat bones, it is the juxta-epiphyseal regions, that is to say, the edges supplied with epiphyses, that are most exposed to osteitis. The pelvis and the scapula frequently present a demonstration of this law. Osteitis of the pelvis, which is so common during the period of growth of the skeleton, is seen especially at the time of puberty and at the end of the period of growth, as Gouilloud² has shown by numerous examples. In the calcaneum, the posterior extremity of the diaphysis, that which is connected with the epiphysis, is also the most common seat of acute osteitis during the period of growth. The anterior extremities of the ribs, near the cartilages, are subject to the same law.

If osteitis of the long bones sometimes produces displacements of the diaphysis by the mechanism indicated above, it likewise gives rise to fractures produced by muscular effort, or in consequence of slight traumatism, in the portion of bone which has lost its firmness under the influence of

¹ Revue Mensuelle de Médecine et de Chirurgie. 1877.

² Des ostéites du bassin. Thèse de Lyon, 1883.

inflammation. These fractures are usually seen during convalescence from osteitis, when the patients, having passed beyond the acute and febrile period, begin to walk again and to use the limb.

Fractures following osteitis are seen especially in the femur. The weight of the body and traumatism act upon this bone in a manner well calculated

Fig. 774.



Double spontaneous fracture of bones affected with osteitis. *A*, fracture of the femur below the trochanter; *B*, fracture of the tibia in the lower third.

to interrupt the continuity of the diaphysis when inflammation has altered its consistence. In the patient represented by Fig. 774, a sub-trochanteric

fracture of the femur, and a fracture of the lower third of the tibia, took place. The former was followed by inward displacement of the lower fragment, the latter by displacement of the lower fragment backward. I have also seen a case of spontaneous fracture following osteitis in the humerus, another in the first phalanx of the thumb, etc.

These fractures occur in two conditions, which make a great difference in the prognosis. Either they take place in a bone simply rarefied and no longer suppurating, or they occur at a centre of suppuration or in a necrosed portion. In the latter case the rupture may occur at the edge of the sequestrum; then it is only a sudden and speedy separation of the necrosed part, or else it involves only the portion of bone which is still living, the sequestrum being already isolated from it. The coincidence of a centre of suppuration, with or without necrosis, aggravates the prognosis. I lost some time ago, from pyæmia, two patients affected with old osteitis, who had broken the femur under these circumstances.

Apart from this risk, these fractures may be very hard to reduce, if time has been allowed for displacement to occur. The resistance of the chronically inflamed tissues prevents exact coaptation, and favors the production of deformity.

NECROSIS OF BONES.

Necrosis is not a disease, it is the termination or sequel of a disease. It is, as its name indicates, the death of the bone. A necrosed bone becomes a foreign body which the processes of elimination constantly tend to isolate from the living part. The isolated portion is called a *sequestrum*, but the word sequestrum is not synonymous with necrosis. The word sequestrum means a separated part. Thus, among the pieces of bone found to be movable in a patch of osteo-myelitis, some are wholly deprived of life and constitute the *sequestra of necrosis*, while others are still traversed by vessels and united with the neighboring tissues by vascular granulations; these are the *sequestra of osteitis* or of *caries*, that is to say, parts still living, isolated from the rest of the bone by peripheral medullization.

Among the sequestra of necrosis two varieties must be distinguished: primary sequestra, and consecutive or secondary sequestra. The first are the result of rapid death of a healthy bone, deprived of its vessels by any cause. The bone is dead without having been diseased, or at least without having had time to be altered by disease. It has, then, the structure, the consistence, and the hardness of healthy bone. The secondary or consecutive sequestra result from the death of a portion of bone already modified in structure by disease. They present the anatomical characteristics of the osteitis which has preceded and led to their death. They are usually rarefied, sometimes eburnated.

Nothing is more variable than the shape of sequestra. They correspond with the vascular territories, that is to say, with the distribution of the nutrient vessels of the bones. Being the immediate result of obliteration of these vessels, they represent the extent and shape of the obliterated vascular territory.

Bone-tissue is the more predisposed to necrosis the more it is compact, that is to say, the fewer vessels it contains, and the greater difficulty there is in establishing the collateral circulation. The vessels contained in the canals of Havers cannot undergo the processes of acute inflammation without being exposed to obliteration, and, as others cannot be established alongside of them, their obliteration is followed by death of the part which they nourish. In the spongy tissue the re-establishment of the circulation is easier, on

account of the large size of the medullary spaces and the relatively free communication between them. Young bone-tissue is, other things being equal, less liable to necrosis than old bone-tissue. It is always the same question of vascularity. It is sometimes said that necrosis is more common in children than in adults. This is true, if regard be had only to the number of cases of necrosis; it is untrue, if it means that the bone of a child mortifies more easily than that of an adult. Under the same anatomical conditions, the bone of the adult is much more liable to necrosis than that of the child; and if account be taken of the large number of bone-affections in children, and of the relatively small number of cases of spontaneous osteitis in adults, the truth will be discovered by reversing the above proposition. Vascular communication between the different parts making up the bone takes place so easily in childhood, that necrosis is possible only after extensive vascular destruction.

It is often said that denudation of bone causes necrosis. I have shown by numerous and varied experiments that this is not so. I have, in young subjects, removed the whole of the periosteum of the diaphysis, or have completely emptied the medullary canal, without producing necrosis.¹ I have even, in certain experiments, removed simultaneously the periosteum and the medulla without causing death of the bone. But, in order that life shall be preserved in these cases, it is necessary to obtain immediate union of the wound, that is to say, immediate adhesion of the tissues peripheral to the denuded bone, and to prevent the formation of pus in the medulla. In young bone-tissue, medullization of the canals of Havers takes place so rapidly, and anastomoses of these canals are then so readily established, that the circulation is restored.

What brings about necrosis is not the denudation of the bone, it is the inflammation which follows this denudation. At a seat of fracture protected from the air, completely movable splinters become engrafted and continue to live.

In operations upon man and in experiments upon animals, it is possible nowadays, by means of vigorous antiseptic, to preserve the vitality of bone-tissue after the severest traumatism. Formerly, necrosis almost always resulted under these circumstances; the wounds became inflamed, and, the vessels of the bone being obliterated, its death was the inevitable consequence. The bones, as I long since proved,² may become engrafted like other living tissues; they are engrafted by the periosteum and by the medulla, especially by their periosteum. Completely detached scales may continue to live, not only in a protected fracture, which is the rule, but also in open fractures, to the seat of which air may have entered. It is a question of asepsis.

But if denudation of a bone does not of itself cause necrosis, if the destruction of its periosteum or medulla is not followed by death of the bone-substance, it does not follow that denudations of bone are not serious complications, either in spontaneous or in traumatic osteitis. In amputations, the end of the bone, more or less deprived of its periosteum, is liable to annular necrosis, and extensive periostitis with separation of the membrane causes more or less extensive necrosis, even without concomitant osteomyelitis.

After necrosis by denudation and necrosis from acute inflammation, I ought to mention necrosis from progressive anæmia of the bone, such as is met with in certain inflammatory processes which produce at different points progressive eburnation. To the rarefaction of the first period of osteitis succeeds a condensation, or rather an eburnation of the bone-tissue, which may go on to obliteration of most of the canals of Havers. From this come the

¹ *Traité Expérimental et Clinique de la Régénération des Os*, t. i.

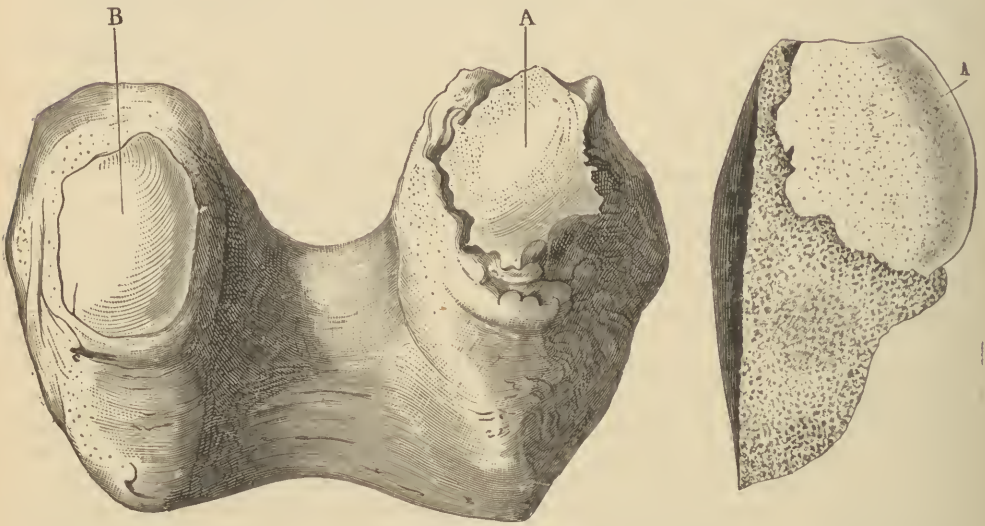
² *Des greffes osseuses* (*Journal de la Physiologie de Brown-Séguard*, 1869).

eburnated sequestra which are found in the midst of purulent or fungating foci, and which many surgeons have considered, since the researches of Nélaton, as tuberculous products. I cannot admit this interpretation without reserve, so far that I do not consider these eburnated masses to have been originally the seat of the tuberculous neoplasia. I do not regard them as tuberculous, but as para-tuberculous products, if I may so express myself, that is to say, products formed alongside of tuberculous deposits. They are one of the multiple forms of chronic osteitis which accompany tubercle of the bones, but not a phase of tuberculosis itself.

Figs. 775 and 776 show a specimen of these eburnated masses, which take a long time to form, and which are but slowly separated from the organism. I cannot admit that these masses, which by their eburnated nature are very refractory to tuberculosis, can be its product. Figure 775 shows the articular

Fig. 775.

Fig. 776.



Condyles of the femur, removed in a resection of the knee, presenting at their lower part hard masses, eburnated by condensing osteitis. The mass *B* is continuous with the neighboring portions of bone. The mass *A* is already to a great extent isolated from the healthy tissues. In the section, Fig. 776, it is seen to be necrosed, except perhaps at its upper part, where in the fresh specimen an irregularly outlined, slightly rosy point could be distinguished.

surface of the condyles of a femur, the protruding part of which is deprived of cartilage, smooth, and eburnated. The internal condyle shows a sequestrum which is beginning to be separated from the surrounding parts; on the external condyle, separation has not yet begun appreciably. In the section of the internal condyle (Fig. 776) it is seen that the eburnated part corresponds to a mass of the same structure, which occupies a large part of the thickness of the bone.

Doubtless tuberculous products may be found around these eburnated masses; but they have never been found in their tissue. The histology of these eburnated sequestra has been well studied by Ranvier, who found in their structure the remains of the old bone which had escaped the rarefying osteitis, in the midst of bony deposits of new formation. The arrangement of the lamellæ differs in the two tissues.

The sequestra of osteitis, which are, I repeat, only living portions of bone

isolated from the neighboring parts by peripheral medullization, may present all the anatomical characteristics which are met with in the different forms of osteitis. These sequestra often present necrosed parts, and then constitute *mixed sequestra*, which have in part the character of sequestra of necrosis, and in part the character of sequestra of osteitis. These sequestra behave quite differently in the midst of living tissues. The sequestra of original necrosis, when they are formed from the compact tissue of the diaphysis, may remain indefinitely inclosed in a suppurating cavity. Pus does not alter them, or at least does not dissolve them. I have removed from the middle of the tibia a number of small sequestra which had remained shut up for more than half a century. I have removed almost the whole of the diaphysis of a femur which had been necrosed for seven years, and which had undergone no appreciable alteration. But, if pus does not dissolve them, vascular granulations, arising from the medulla, may after a while alter and absorb them. Ivory pegs driven into the bones for the cure of pseudarthrosis, are eroded by the granulations which surround them. Small portions of dead bone introduced into the midst of living tissues, either in the medullary canal or in the cellular tissue, disappear at the end of a certain time. They disappear, above all, when the wound does not suppurate, or suppurates but slightly. As I have just said, pus does not dissolve them, but the granulations absorb them. Vascular tufts enter the canals of Havers, penetrate them, enlarge them, and finally absorb them by lacunar erosion, by a process which has some analogy with that of osteitis, but which differs from it inasmuch as the granulations come from tissues foreign to the bone.

While these small sequestra of necrosis may at length disappear by means of absorption effected by the peripheral granulations, the sequestra of osteitis disappear by an altogether different mechanism. They disappear by medullization, that is to say, by a continuation of the process of rarefying osteitis. It is their own medullary elements that absorb the bony substance all around them.

One of the most interesting phenomena to be studied in the history of necrosis, is the mode of repair of necrosed bones. For a number of centuries there had been noticed, after necrosis, examples of the regeneration of bone (Sculetus, Ruysch, etc.), and the explanation which was given of these cases was always based upon the physiological ideas of the times. After the celebrated experiments of Duhamel, the regeneration of bone was sought to be explained by the periosteum. The researches of Troja were interpreted in this way. Then, following Bichat, Scarpa, and Lévillé, the periosteum was dispossessed of all regenerative power, and regeneration was sought to be explained by hypertrophy of the remaining bone. I have elsewhere¹ discussed at length all these questions, and I have shown how far from accurate are the theories based upon cases of necrosis observed in man. It is impossible thus to analyze accurately the phenomena of regeneration; so many influences may contribute to it, that arguments can be found in favor of all theories. Experimental analysis is indispensable in order to unravel the problem, and further, it is necessary to have recourse to processes of experimentation more exact and more demonstrative than the production of artificial necrosis.

The periosteum is unquestionably the most important organ in the regeneration of bone. It is the only organ which can bring about regeneration of a considerable portion of bone, or of an entire bone. The medulla may indeed ossify—it is often transformed into bone-tissue in osteitis; but it does not follow from this that it can of itself repair an entire bone or a diaphysis.

¹ *Traité Expérimental et Clinique de la Régénération des Os*, t. i. et ii.

While it ossifies when it remains in contact with the bone, it usually remains soft and pliable when the peripheral cylinder of bone has been destroyed by necrosis or artificially removed. The periosteum, on the contrary, isolated from the bone, reproduces bony masses which, in conditions which I have determined experimentally, recall the form and dimensions of the bone removed. Its ossifying properties are dependent upon the conservation of its osteogenic layer, that is to say, of the layer of embryonic cells which exists on its deep surface. This layer is very easy to demonstrate in the bones of young subjects, especially in children; but it disappears in adults and old persons, and becomes apparent in these last only when the periosteum has been previously irritated. Artificial irritation of the periosteum restores to this membrane, in old animals, the properties of youth. For this reason bony new formations are not limited to childhood and adolescence; they may be produced at a later period when the periosteum has undergone a certain degree of irritation, which renews in its cells the properties which they had lost.

In necrosis of the whole thickness of a bone, regeneration is dependent upon this osteogenic layer. If it has been destroyed by the violence of the inflammation, as happens in diffuse periostitis which in a few days transforms the periosteal sheath into a purulent sac, in which the whole of the diaphysis is found necrosed, regeneration may fail utterly in spite of the youth of the subject. I have seen, among other cases, a necrosis of the ulna, following a very acute pan-diaphysitis, which was not followed by the formation of the smallest osteophyte, although the child was only four years old.

Acute inflammations which begin in the periosteum, often destroy the whole of the osteogenic layer. Inflammations originating in the medulla, which attack the periosteum only secondarily, are of less gravity in this respect. Intense and destructive in the medulla, these inflammations lessen in intensity as they traverse the bone-substance, and reach the periosteum so much enfeebled as to provoke only plastic processes. Hence those enormous subperiosteal bony layers which are provoked by irritating the medulla in animals, and of which clinical observation furnishes frequent examples in children. On this account the seat and point of departure of inflammation have a great influence upon the regeneration of bone. If indirect irritation of the periosteum is usually fruitful, its direct irritation runs a risk of being sterile when it is too intense.

Nothing is more simple, apparently, than the theories of regeneration given by different authors who have wished to apply to surgery the ideas of Duhamel and of Troja. By the action of the periosteum or of the medulla, which, according to these theories, is only an internal periosteum, all is explained. It is sometimes one, sometimes the other of these tissues which does the work. In reality, the question is more complicated; and when we consider the majority of the sequestra removed by sequestrotomy, we can understand how Brun, Lévillé, Scarpa, etc., maintained that the new bone was only the result of hypertrophy of the part remaining. Indeed, in the majority of the sequestra removed, it is seen that they are not made up of the whole thickness of the cylinder of the diaphysis. There generally remains a portion which has continued to live, and which may have played an important part in the reconstruction of the bone. Total necrosis is rare. There generally remain, even in cases in which a superficial examination would lead to the belief that the whole bone had become necrosed, some living portions adherent to the periosteum, which will play an important part in the osseous new formation.

When a sequestrum, representing the greater part of the diaphysis of a long bone, is examined attentively, it may be determined, from its shape and

appearance, by what elements the new bone has been reconstituted. If the sequestrum is smooth and single, without erosions or losses of substance, the new bone can only have been reconstructed at this point by the periosteum. If its continuity is interrupted in part of the circumference, if it is reduced in some places to a portion of the normal thickness of the bone, reconstruction has taken place both by the periosteum, which corresponds to its smooth surface, and by portions of the old bone, which correspond to the eroded or absent parts. I am speaking here only of the sequestra of frank necrosis, resulting from acute osteitis, that is to say, of parts of bone dying suddenly, without having been previously affected, and therefore having the character of healthy bone-tissue.

Now, in these cases, the sequestrum represents exactly the bony deficit; the erosions and the deep furrows which cross its surface have not been made at its expense; these inequalities indicate that small portions of the superficial layer of the bone have remained adherent to the periosteum.

It is in the large bones of the limbs that the most beautiful examples of regeneration of bone have been observed. Yet all the bones may be reproduced more or less. The short bones themselves, and the epiphyses, are susceptible of a certain degree of reproduction, which is proportioned to the extent of their periosteal sheath. The portions of bone in great part covered with cartilage, like the head and neck of the femur, the astragalus, etc., are hardly susceptible of reproduction. The periosteum can reproduce only that which it encases, and that of which it furnishes the normal materials of growth. Examples of reproduction of the diaphysis of the large bones of the limbs have been known for a long time, and there is not a pathological museum which does not possess some specimens of the kind. I give here (Fig. 777) a drawing of a specimen in the Musée Dupuytren, which relates to a necrosis of the lower three-fourths of the diaphysis of the humerus. The necrosed diaphysis is surrounded by a peripheral ossification which can only be attributed to the periosteum.

The flat bones are also susceptible of reproduction by the same mechanism, and the necrosed lower maxilla is sometimes seen included between two ossified layers of new formation, one inside the mouth, the other outside. The same is true of the scapula; the old bone is included between two plates formed by periosteal ossification.

Regeneration of the short bones has been rarely observed after necrosis. I reproduce here (Fig. 779) an illustration of reproduction of a bony shell around the necrosed calcaneum.

Surgeons have always been divided on the question of the proper time for interference in necrosis; not in regard to the removal of movable sequestra, for all are agreed on this point, but in regard to the removal of necrosed parts still adherent to the periosteum to a certain extent, or still connected with a healthy part of the bone. There will be but little serious difficulty if regard be had to the mode of regeneration of bones after necrosis, and to the nature of the work by which the repair of sequestra takes place.

When the inflammatory phenomena have abated, when the pus is in small quantity and flows freely, when septic accidents are no longer to be feared, the separation of the sequestra ought to be left to nature, or at least not precipitated. There would, in this case, be a risk of deranging the plastic process which is going on, and of reviving the inflammation which is just dying out. But it should be well understood that one should thus wait only when it can be done without danger and without too much inconvenience to the patient.

Whenever the presence of the necrosed portion keeps up abundant supp-

ration which may exhaust or poison the patient, this necrosed portion should be removed.

Fig. 777.



Fig. 778.

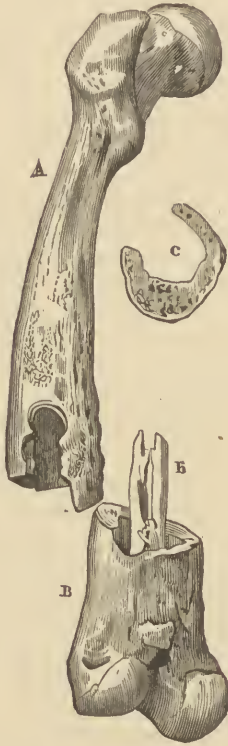


Fig. 779.



Fig. 777. Case of necrosis from the Musée Dupuytren. Almost the whole of the diaphysis of the humerus has perished. The new bone is completely solidified. Cloacæ are seen, openings which expose to view a large, movable, invaginated sequestrum, free in the cavity of the new bone. (Musée Dupuytren, No. 346.)

Fig. 778. Invaginated necrosis of the lower part of the femur. The bone is represented cut in three pieces. *A*, the upper fragment; at its lower part is seen a large hole made with the trephine. *B*, is the lower fragment; the sequestrum is seen to be invaginated at the end toward the condyles. *C*, is a section of the bone which shows the areolar structure of the ossification.

Fig. 779. Necrosis of the calcaneum; ossification of the periosteal sheath around the necrosed bone. (After Gerdy.)

In necrosis of the maxillæ, for example, the flow of pus into the mouth is a constant source of poisoning; in necrosis of the whole diaphysis of the tibia, suppuration over so extensive a region exhausts the organism. Then the cause which keeps up the suppuration should be removed, whatever effect the operation may have upon the properties of the periosteum. Regeneration of the bone is of secondary importance here; to save life is the first consideration.

To conclude, necrosed parts ought to be removed if they are doing harm, and their separation should be waited for if they are not causing serious trouble. The longer one waits from the time when fever and constitutional symptoms have come to an end, the better the chance of finding the periosteum in possession of all its osteogenic properties. As soon as the fever declines, the destructive processes are arrested, and the plastic processes become more active. The periosteum thickens more and more, increases in consistence, and becomes like cartilage. The dead bone keeps up, it is true, a certain degree of

irritation in the affected region; but this irritation is productive of ossification; it excites and maintains the proliferation of ossifiable cells. The periosteum is now in favorable osteogenic condition, and may be easily, and without danger, separated from the bone at the points where it still adheres.

As soon as the periosteum is found in this condition, the necrosed portion may be removed, although it may not have precise limits. The duration of suppuration is thereby shortened, incarceration of the sequestrum in an ossified cavity is avoided, and finally the patient is cured more quickly without compromising the regeneration of the bone. Lister's dressing gives another reason for hastening these operations; by preventing inflammation of the wound, it prevents the renewal of destructive processes.

The relations of the bone furnish also a guide for hastening or delaying an operation. If the bone concerned is the sole support of a limb, like the humerus or the femur, it is well to leave the periosteal sheath to become hyperplastic, and even to give it time to harden. A tissue already of the consistence of cartilage will soon be invaded by ossification, and may, with the help of a supporting apparatus, maintain exactly the shape of the limb.¹ I insist the more on this preparation of the periosteum, because I have seen regeneration fail to take place in children in whom the diaphysis of the tibia had been removed for osteo-myelitis with small intra-medullary sequestra, without waiting for sub-periosteal hyperplasia.

The extraction of sequestra does not constitute a resection; the operation is the same as for the removal of a foreign body. It has been given the name of *sequestrotomy* or *necrotomy*.

Systematized and practised with temerity by David, at the end of the last century, this operation is at the present day one of the commonest in surgical practice. It differs much according as one has to do with a superficial sequestrum, or with a sequestrum incarcerated in thick layers of newly formed bone.

Ablation of a movable sequestrum, superficially situated and covered by only more or less indurated fibrous layers, necessitates only an incision of the soft parts; but extraction of an incarcerated sequestrum often necessitates a preliminary operation, which in certain regions is laborious and difficult. It is sometimes necessary to cut with the gouge, chisel, or trephine, large openings in the bone, which is considerably thickened by the deposit of sub-periosteal layers of new formation. A small sequestrum, incarcerated in a region difficult of access, often requires a long and laborious operation, which risks breaking the bone if the needful precautions are not taken to control the position of the limb.

These operations, practised upon bones hypertrophied by inflammation, have always been less grave than analogous operations upon healthy bones. The eburnation of the peripheral bone, and the obliteration of the medullary canal, altogether change the character of these osseous wounds. And they are still less to be dreaded nowadays with antiseptic dressings.

If the extraction of movable sequestra is a totally different operation from resection, it is not the same as regards removal of necrosed parts which are not yet separated from the healthy bone. If, for example, we cut away a juxta-epiphyseal or articular extremity, which is bathed in pus but still attached to the rest of the bone, from which it cannot be distinguished by precise limits, then we do a true resection involving the healthy bone. These resections for adherent necrosed bone are made necessary by the abundance

¹ Scultetus (*Armamentarium Chirurgicum*), as early as the seventeenth century, removed the dead bone in a number of cases by incising the thickened periosteum, which he called cartilage. Cartier (*Précis d'Observations de Clinique faites à l'Hôtel-Dieu de Lyon, 1802*), removed the whole diaphysis of the tibia while the periosteal sheath was soft and flexible. The limb was placed in a fracture apparatus, and the bone re-formed, preserving almost its original shape.

of the suppuration, and by the infective complications which stagnation of pus may cause. They may be insufficient if the section of the bone comes just to the level of the apparent limits of the necrosis, it being possible that the necrotic process may extend secondarily to the inflamed parts. It is necessary, then, if we do not wish to run the risk of seeing a greater or less extent of the end of the bone die, to saw where the bone is perfectly healthy; and even in this latter case we may have secondarily an annular necrosis, if the periosteum has been stripped up too far, and if the wound becomes consecutively the seat of a suppurative inflammation.

The rule to leave to Nature the care of limiting and separating necrosed parts, has its drawbacks in certain regions. It has everywhere the disadvantage of requiring much time, and of prolonging the period of suppuration. For a long time surgeons have asked themselves if the separation of sequestra ought not to be hastened by scraping, by shelling off, and by perforating, the bone. Belloste, in order to quicken the separation of sequestra of the cranium, recommended perforating the dead part with a number of holes, penetrating to the living part and making it possible for granulations to emerge through the sequestrum and contribute to its absorption. Before the time of antiseptic dressings this method had no advantages, and some comparative experiments which I formerly made demonstrated that the separation of sequestra was not hastened, and that there was danger of increasing the necrosis in depth by the simple fact that new wounds were made, which were prone to inflame and to become infected.¹

With the antiseptic method we may attack these superficial necroses more boldly, removing the necrosed part promptly with a chisel or raspatory penetrating to the healthy bone. Poncelet has thus accelerated cicatrization of denudations of the cranium.² In many other regions we should adopt the same plan, lest we should see bone-wounds slowly suppurating for months, when scraping or superficial removal might have cured them in a few days.

Sequestrotomy sometimes reduces itself to simple extraction of the sequestrum. The dead bone removed, all returns to order; the cavity rapidly fills with granulations which soon form a fibrous mass and finally ossify, especially if the periosteum can take part in the process. It often happens, however, that these cavities are obliterated by fibrous tissue which persists indefinitely; but this lack of ossification is especially seen in chronic lesions involving the spongy tissue. In frank necrosis, and in young subjects, the plasticity of the walls of the sequestrum-cavity generally bring about bony consolidation.

In osteo-myelitis which passes on to the chronic state, and gives rise to the complex anatomical forms which I have described, we must not be content with removing the small movable sequestra which are discovered, but should scoop out the whole of the affected region, and remove the altered medulla, whether gelatinous or fungous, which is found there.

¹ *Traité de la Régénération des Os*, t. ii. chap. i.

² *Deporte, De la nécrose superficielle (Thèse)*. Lyon, 1882.

SCROFULO-TUBERCULOUS AND OTHER STRUCTURAL DISEASES OF BONES.

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SCROFULO-TUBERCULOUS AFFECTIONS OF BONES.

UNDER this title I shall consider together scrofula and tubercle of the bones, because their pathological histology tends more and more to become similar, and because it is impossible to give a sketch of them separately without falling into frequent repetitions. Scrofula is only a mitigated manifestation, initial and usually external, of tuberculosis, and it leads to the latter more or less rapidly. The forms of chronic osteitis which appear under the influence of these two phases of evolution of the same diathesis, or general tendency of the organism, have not well-defined characteristics which differentiate them exactly. If the general appearance of the patient reveals the traits attributed to scrofula, or to tuberculosis, the osteitis is spoken of as scrofulous or tuberculous, although this distinction may not be fully warranted either by the symptoms or by the pathological anatomy of the affection. Even the microscope does not assist in this separation, for it reveals, in most sections of these inflamed bones, both embryonic tubercles (*scrofulomata* of Grancher) and fully developed tubercles (*gray granulations* of Laënnec).

If the embryonic or adult tubercle, if the bacillus or the zoöglar masses are what characterize tuberculosis in process of evolution (scrofula) as well as that which has already undergone evolution (tuberculosis), my description ought to include not only the subject of *tuberculous affections of the bones*—a chapter created by Nélaton—but also *caries*, with its varieties, and *spina-ventosa*, lesions in which these neoplastic or parasitic elements are found. I ought also to mention *ossifluent abscesses*,¹ sessile or by congestion, as well as *white swellings* (fungous osteo-arthritis), which are extremely common consequences of the localization in the bones of tuberculosis in its different stages of evolution.

HISTORICAL AND GENERAL CONSIDERATIONS.—The history of scrofulo-tuberculous osteopathies is not very old. Its first page was written by Nélaton,

¹ [Ossifluent abscesses are such as originate or “flow” from bone-disease; sessile abscesses are those which are found in contact with the diseased bone, and abscesses by congestion those which occur at a greater or less distance.]

who first described the morbid entity, *tuberculosis of the bones*, separating it from the group *caries*. After numerous vicissitudes, the idea of the French surgeon was accepted by the whole world, so much so that at the present day tuberculosis only is recognized in chronic osteitis, and caries itself is regarded by many as a tuberculous affection of the bones. Not merely a branch of the group, but the whole morbid group of caries belongs to tuberculosis.

In his historical sketch, Professor A. Nélaton¹ traces back to the earliest times the knowledge of tuberculosis of the bones. He says that Hippocrates and Galen mention tubercle of the bones in the most precise way. Marcus Aurelius Severinus and Mercurialis also speak of it at great length. In 1735, Traugott Gerber treated likewise of vertebral tuberculosis as of a thing well known, and attributed to it the formation of spinal curvatures. The collection of dissertations of Platner contains, finally, a thesis of Frederic Haacke, "the title of which alone, *De iis qui a tuberculis gibbosi fiunt*, suffices to show what were the ruling ideas at that time in regard to this point of science."

The word tubercle is indeed frequently found in the works of the oldest authors; but this is all. This word had not at first the meaning which we have attached to it since the time of Laënnec and Bayle. Every morbid product of small size and of globular or nodular shape was called tubercle. There were scrofulous, syphilitic, and cancerous tubercles, etc. The word tubercle referred only to shape, while now it refers both to shape and to nature; that is to say, to the something which gives rise to general phthisis, and especially to the most common and best known type of this disease, pulmonary phthisis. If, then, the employment of the word is ancient, the idea of the thing is modern. It begins with the immortal works of those French physicians, Bayle and Laënnec, upon phthisis.

Delpech² appears to be the first who, with a true notion of tubercle, raised the question of tubercle of the bones. In 1830, Serres, of Montpellier, developed the teaching of his compatriot. In 1835, Nichet, of Lyons, discussing Pott's disease, like his predecessors, followed their example in considering it a tuberculous affection of the bones.³ Pott's disease also furnished the subject of the researches made by Reid, of Erlangen,⁴ Parise,⁵ Tavignot,⁶ and others. All these authors studied only Pott's disease, and endeavored to prove that this disease was not common caries, but a tuberculous affection.

"That which Bayle and Laënnec did for the lung, in explaining the natural history of the evolution of tuberculosis, remained yet to be done for bone-tissue; this is the point in the pathology of the bones, of which," says Nélaton, "I have endeavored to treat."⁷ Nélaton distinguishes, in the bones, two forms of tuberculosis. Sometimes the tuberculous matter is found collected in one or several centres, hollowed out of the substance of the bone-tissue (*encysted tubercle*); sometimes it is infiltrated in the cells of the spongy tissue (*tuberculous infiltration*). Each of these forms has anatomical characteristics which make it possible to differentiate it at all stages of the disease. Thus, the nature and modalities of the affection are well described by Nélaton, whose doctrine regarded not the vertebræ only, but the whole of the osseous system. There has been cited, as having preceded him in this matter, a physician of the name of Suren, who, in 1834, issued a thesis⁸ in which he described the miliary and conglomerate, as well as the infiltrated, forms of

¹ *Eléments de Pathologie Chirurgicale*, t. ii.

² *Traité des Maladies Réputées Chirurgicales*, t. iii. 1816.

³ *Mémoire sur la nature et le traitement du mal vertébral de Pott.* (*Gazette Médicale.*)

⁴ *Annales de la Chirurgie Française et Étrangère*, 1843.

⁵ *Archives Générales de Médecine*, 1843.

⁶ *L'Expérience*, 1844.

⁷ *Thèse inaugurale*, 1836.

⁸ *De ossium tuberculis.* Berolini, 1834.

tubercle of the bones. It is beyond doubt that Nélaton had not the least knowledge of this obscure dissertation, otherwise he would have cited it—he who had taken such pains to discover those who had preceded him in the most remote ages. It is not less certain that, if tuberculosis of the bones had had no other advocate than Suren, we might still be ignorant of it.

Since the monograph of Aug. Nélaton, many papers on tuberculous affections of the bones have been published by Denonvilliers, Lebert,¹ Robin,² Malespine, Virchow, Ordonez, Gonzales Echeverria, Chassaiguac, Cornil and Ranvier, Gerdy, Volkmann, Lazarus, Bennett, Goetz, Macnamara, Gosselin,³ Baumgarten, Abelin, Lannelongue, Kraske, Parrot, König, Köster, Sonnenburg, Heydenreich, Kiener, Poulet, Martin, Charles Nélaton, Albert, Ollier, and others. I cannot mention all the authors. Among these, agreement is far from being complete. Some deny or limit, others accept and extend, the teachings of Nélaton. The fluctuations of medical opinion relative to the nature of tuberculosis in general, have been felt at all times in the ideas of surgeons who occupy themselves with the pathology of the bones.

In 1850, Reinhardt opened the campaign against the unity of phthisis, by affirming, on the evidence of the microscope, that the tuberculous infiltration of Laënnec was only a catarrhal pneumonia, in which the lung was incapable of freeing itself from the products of inflammation. Then came Virchow, declaring with the authority of his name that the gray granulation was the sole and only criterion of tuberculous affections, and that the infiltrations called tuberculous, the caseous masses seen in the lungs of the phthisical, were only inflammatory products in scrofulous persons. There were, therefore, two varieties of phthisical persons, those whom gray granulation made truly tuberculous, and those whom caseation of the inflammatory products of a pneumonia rendered merely phthisical. Ranvier was the ardent propagator of these trans-Rhenal ideas in France. Dualism substituted itself in this manner for unicism; and consequently all caseous products infiltrated in the spongy tissue of the bones were considered as simple purulent collections in retrograde metamorphosis. Then nothing was spoken of but caseous osteitis; to admit tuberculous osteitis, the gray granulation was absolutely required.

The restoration of unicism has now restored to the doctrine of Nélaton all the ground lost, with more or less legitimate additions.

To M. Grancher is due in large part the honor of having dethroned German dualism, and of having brought about the triumph of the principle of unicism established by Laënnec. He can write with full justice: "I have contributed, for my part, to overturn that doctrine of dualism, by showing the different stages of evolution of a tuberculous granulation, from its embryonic period to its old age; and also the various transformations which it may undergo, according to its evolutionary tendency, toward the caseous, or towards the fibrous state."⁴ According to M. Grancher, the granulation of Laënnec, the gray, semi-transparent granulation, is not an initial, but an adult product. "Other granulations, yellow and soft, are also adult products, in which the caseous state predominates, and the evolutionary tendency of which is toward fusion with other near granulations to form a giant tubercle. These, in their turn, unite, invade a lobe of the lung, or even an entire lung, and give rise to tuberculous pneumonia, then called caseous. The tubercle, then, exists before the gray or yellow granulation, and after it. Its definition ought not to be limited to the adult age, it deserves this name also in the earlier and later periods, that is to say, during the whole course of its evolu-

¹ *Traité Pratique des Maladies Scrofulieuses et Tuberculeuses.* Paris, 1849.

² *Littre, Dictionnaire de Médecine*, 15e édition. Paris, 1884.

³ *Clinique Chirurgicale de la Charité*, 3e édition. Paris, 1884.

⁴ *Dict. Encyclop. des Sciences Médicales*, Art. Scrofulé.

tion." M. Grancher has been able to follow the different phases of evolution of the tuberculous process, to see it pass from the rudimentary state to the state of complete development. At the beginning there is an ordinary cellular proliferation, common granulation-tissue, which would not have any significance if there were not in its neighborhood more advanced formations. These embryonic cells arrange themselves in a circle, and group themselves into microscopic nodules. This is what M. Grancher calls an embryonic tubercle, and M. Malassez an elementary tubercle.

This tubercle, or embryonic nodule, being met with in larger numbers in scrofulous affections, M. Grancher also calls it scrofuloma. Scrofuloma is characteristic of scrofula, and, engendering tubercle, explains how a scrofulous person may become tuberculous, and how the same patient may perhaps have at the same time strumous and tuberculous lesions. The following is the mode in which scrofuloma becomes tubercle, according to M. Grancher: In the centre of the group of cells there appears a homogeneous mass, opaque and yellow, in a new evolution, surrounded by clusters of epithelioid cells. This collar of epithelioid cells is itself surrounded by a zone of embryonic cells. What has happened? The original embryonic cells of the centre of the group have undergone transformations which have provoked their fusion. The fusion of these cells gives rise to the cell called a giant-cell, and announces caseous degeneration. So think MM. Charcot and Grancher. According to others, the so-called giant-cell is made by cutting across the small vessel, pre-existent or of new formation, around and at the expense of which the tuberculous follicle is developed (Cornil and Ranvier, Kierner, etc.). The union of a number of tuberculous follicles in a single mass constitutes the complete maturation of the tuberculous process, that is to say, the old gray granulation of Laënnec, the conglomerate tubercle of M. Charcot.

If such is the evolution of tubercle, the gray granulation, which suffices, when it is present, to fix the character of a lesion, can no longer be considered the univocal criterion of tuberculosis. Which is the metamorphosis of the tubercle-cell, which is the most constant? The study of this question has called forth numerous histological works. In 1868, Langhans, after having discovered the epithelioid cells and the giant-cells, believed that those cells alone were characteristic of tuberculosis. Schuppel adopted these ideas. Köster having found the giant-cell and epithelioid cells in fungosities of the joints, Friedlander in lupus, and at a later period Brissaud and Josias in scrofulous gummata and Lannelongue in the walls of independent cold abscesses as well as in those of ossifluent abscesses, there was no hesitation in declaring the characteristic suggested by Langhans and Schuppel to be true. But soon the same elements—tuberculous follicles and giant-cells—were met with in the gummata of syphilis, in the ulcers of lepra, in sarcoma, in granulations; and, to complete the confusion, tuberculous follicles and giant-cells were obtained at will by injecting animal matters, or any inert matter whatsoever, into the lungs, the bloodvessels, the cellular tissue, and the peritoneum of animals, or by simply placing in their abdomen elder-pith, fragments of glass, etc. The univocal criterion of tuberculosis was, then, still to be sought for.

It was at this time that M. Martin¹ was led by experimentation to distinguish *true tubercles* and *pseudo-tubercles*. The latter are only common inflammatory products provoked by the injection of irritating materials into the tissues, and, when they are inoculated upon new animals, they are not reproduced; whilst the tubercles resulting from the inoculation of true tuberculous matter, inoculated in their turn, are reproduced indefinitely from one animal to

¹ Archives de Physiologie, 1881.

another, giving rise constantly to generalization of the tubercle. This is what is called inoculation and generalization in series, a method up to the present time uncontested, and the only one by which to distinguish true tubercle from pseudo-tubercle. Before M. Martin, M. Colin, of Alfort,¹ and M. Toussaint had already established the generalization in series of tuberculous inoculations. But it was undeniably M. Martin who first sought by this method of experimentation the means of surely distinguishing pseudo-tubercle from true tubercle. The capital fact upon which generalization in series rests is the *inoculability of tuberculosis*.

The inoculability of tuberculosis in both its forms had been demonstrated as early as 1865 by M. Villemin,² who had also practised inoculations in series to refute the objection which was made to him, viz., "that tuberculous matter taken from a human corpse might well have no other action than that of a cadaveric substance."³ In 1869, M. Chauveau rendered a number of animals tuberculous by making them swallow tuberculous matter obtained from the lungs of phthisical persons. Inoculability by the digestive passages was thus demonstrated. It is not necessary for me to dwell upon the importance of these researches of French experimenters, in regard to alimentation and hygiene.

What is the infecting agent in these inoculations? Is it a chemical substance, or is it a micro-organism, which is carried and which is propagated in inoculations and in generalizations in series, and which gives to tuberculosis its virulence and its specific character? The general tendency of thought is at present altogether in favor of a parasite, which, in spontaneous tuberculosis, is introduced into the organism by the air-tubes, or the digestive or other passages, fixes itself in the tissues and fluids, the blood especially, and undergoes evolution there, when the soil is favorable to it by a defect of resistance, hereditary, innate, or required. "M. Bouchard," says M. Debove,⁴ "maintained the existence of the parasite of tuberculosis some years ago in his lectures. Afterwards, Klebs, in Germany, and Toussaint, in France, described it; but it seems clear that the parasite which they described was due to imperfect cultures. The merit of the discovery belongs to Koch, and no one can dispute his claim to it." In 1882, M. Koch isolated and colored the bacillus of tuberculosis. When this bacillus was cultivated, he found it indefinitely in generalizations in series which he effected by inoculations in animals. The demonstration would appear to be complete. The bacillus might be considered the univocal criterion of tuberculosis, and might take the place of the gray granulation, the tuberculous follicle, and the giant-cell. Nevertheless, a conclusion must not be reached too hastily. For MM. Malassez and Vignal have just declared, in a communication to the Société de Biologie,⁵ that they have not found any bacilli in lesions which clinical observation and experimentation have shown to be undoubtedly tuberculous; and that they have found in them another form of micro-organism—micrococci joined in zöoglear masses. There would appear to be, then, a tuberculosis with bacilli, and a zöoglear tuberculosis; and, I would add, there are still many obscurities to be cleared up, in spite of the progress made. It is evident that clinical observation remains, up to the present time, our surest guide.

The general ideas expressed above are wholly applicable to tuberculosis of

¹ Bull. de l'Académie de Médecine.

² Cause et nature de la tuberculose (Bull. de l'Académie de Médecine, t. xxxi. p. 211); Étude sur la Tuberculose, 1867; De la Virulence et de la spécificité de la tuberculose (Bull. de l'Académie de Médecine, Août, 1868, t. xxxiii. p. 746).

³ Chauveau, Journal de Médecine Vétérinaire.

⁴ Semaine Médicale, No. 21, 1883.

⁵ Gazette Hebdomadaire, Mai, 1883.

the bones. Among the most recent works in which tuberculous affections of the bones are considered in the light of the modern views, I ought to mention those of M. Lannelongue,¹ of M. Parrot,² of MM. Kierner and Poulet,³ of M. Dubar,⁴ of M. Charles Nélaton,⁵ and of M. Ollier.⁶ I shall analyze these works in the pages which follow.

CLASSIFICATION AND PATHOLOGICAL ANATOMY OF SCROFULO-TUBERCULOUS OSTEOPATHIES.—The want of certainty which still exists in regard to the nature of some chronic inflammations of the bones, makes it a duty not to separate them too absolutely. I shall therefore classify the osteopathies which are the subject of this work in two groups, viz: *Undoubtedly tuberculous osteopathies*, and *probably tuberculous osteopathies*. In the first category are found encysted tubercle and the tuberculous infiltration of Nélaton; the circumscribed puriform infiltration, or primary and chronic tubercle, of M. Kierner, and the diffuse infiltration, acute tuberculous osteitis, of the same author; the isolated tuberculous granulations and the confluent tuberculous granulations of MM. Cornil and Ranvier; and the generalized miliary tuberculosis of Parrot. The terminology has varied since the time of Nélaton; but his classification remains, and is sufficient. I shall adopt it. In the second category are the caries of systematic authors, spina ventosa, and perhaps the dry caries of Volkmann.

I. UNDOUBTEDLY TUBERCULOUS OSTEOPATHIES.—The habitual seat of these osteopathies is the spongy tissue of the bones. They are found, in order of frequency, in the bodies of the vertebræ; in the extremities of the long bones (epiphysis and juxta-epiphyseal portion of the diaphysis); in the short bones of the hands and feet; more rarely in the flat bones; and exceptionally in the diaphyses of the long bones.

(1) *Encysted Tubercle*.—According to the authoritative description of Nélaton, encysted tubercle presents itself in the shape of a closed cavity containing a yellowish-white, opaque material, resembling putty. This material has a characteristic odor. It is devoid of elasticity and retains the imprint of the finger; it contains no bony particles; it sometimes exhibits marblings of a whiter or grayish tint; it is not made up of concentric layers; it spreads through water without being dissolved, forming grumous masses which float at first in the liquid, but soon fall to the bottom of the vessel. "With the microscope this dense plasma may be seen to contain a considerable proportion of tuberculous corpuscles, mixed with a large quantity of amorphous matter, and a great number of gray or yellow granules, some fatty, others calcareous." (Nélaton.) Except in terms, modern histology has little to change in this description of the French surgeon.

A *cyst-membrane* lines all the anfractuosités of the tuberculous cavity. Its thickness varies from one to two millimetres; it is gelatinous, at first soft, but

¹ Tubercules des os, tumeurs blanches consécutives (Bull. de la Soc. de Chir. 1879). Abcès froid, et tuberculose osseuse. Paris, 1881.

² Du spina ventosa (Gaz. méd. de Paris, 1880).

³ De l'ostéopériostite tuberculeuse chronique, ou carie des os (Archives de Physiologie, 1883).

⁴ Anatomie pathologique des ostéites. (Thèse d'agrégation. Paris, 1883.)

⁵ La tubercule dans les affections chirurgicales. (Thèse d'agrégation. Paris, 1883.)

⁶ Des résections et des amputations chez les tuberculeux (Lyon Médical, 1883).

N. B. Among the recent works to be consulted, I would also mention Renaut, Notion actuelle du tubercule et de la tuberculose (Gazette Heb., 1883). Chandelux, Des synovites fongueuses, articulaires et tendineuses. (Thèse d'agrégation, 1883.) Hanot, Des rapports de l'inflammation avec la tuberculose. (Thèse d'agrégation, 1883.) Quinquand, De la scrofule dans ses rapports avec la phthisie pulmonaire. (Thèse d'agrégation, 1883.) Schmitt, De la tuberculose expérimentale. (Thèse d'agrégation, 1883.) M. Pollonson, Note sur les formes anatomiques de la tuberculose articulaire et l'évolution clinique des fongosités (Gaz. Heb., 1883).

afterwards increasing in consistence, while at the same time its color becomes reddish in consequence of the formation of a vascular network spreading over its surface. From this network depart a number of prolongations which penetrate the areolæ of the bone-tissue, and unite the membrane to the walls of the cavity. The internal surface of the sac is likewise shaggy; its texture is composed of white, fibrous, inextensible, felted filaments, and represents, "in miniature proportions, the texture of the capsules of the joints." (Nélaton.) "Examined under the microscope, this membrane appears to be composed of anatomical elements like those of the matter contained in its interior." From this citation it will be seen that Nélaton had already described the process of encysting and of extension of tuberculous products, upon which M. Lannelongue has recently dwelt in connection with abscesses by congestion.

I understand the series of phenomena which end in the formation of an encysted conglomerate in the following way. Bacilli or micrococci, having been introduced into the circulation, become stranded in the capillary of a Haversian canal, and set up around them the special inflammatory reaction which receives the name of tuberculous follicle, gray granulation, etc., altogether analogous to that which an inert, non-specific foreign body produces. As in every osteitis, the bone-tissue becomes dissolved; a lacuna of Howship is created. The bacilli multiply; they invade new vessels, and provoke new tuberculous formations; other canals of Havers are involved; and so on indefinitely. By ceaseless multiplication of the parasites—a multiplication which establishes an essential difference between the perturbing action of tuberculous parasites and that of non-parasitic foreign bodies, and which explains the difference in extent and in gravity of the disorders which they respectively produce—and by the eliminative inflammation which they excite, it comes to pass that a certain part of the bone is implicated and destroyed. The central tubercles, being ill-nourished, undergo caseous degeneration, while those of the periphery preserve their character in the midst of the fibro-embryonic tissue which secondary inflammation has produced around them. This invaded peripheral portion of the bone constitutes what is called the encysting membrane. In proportion as the bacilli invade the neighboring bony layers, the most central portions of the false membrane undergo in turn caseation from being deprived of the nutrient juices, the access of which is prevented by the obliteration and destruction of the capillaries. The micro-organism of encysted tubercle is probably not the same as that of tuberculous osteopathies with a more markedly invading and acute course. It may not be the bacillus of Koch; it may be one of its evolutionary forms, either more perfect or less advanced. It is quite reasonable to think that the different forms of tuberculosis depend upon different micro-organisms, or, better still, upon a single parasite with many metamorphoses, and which, according to its soil, goes more or less completely through the cycle of its possible destiny. However this may be, the reaction which it causes is but slight in encysted tubercle. The invading process stops, doubtless, when the general and local conditions cease to be favorable to the generation and life of the parasite. Such is my idea of the course of encysted tubercle.

There remain for us to study the bone-cavity of the encysted tubercle and the parts which surround it. The tuberculous cavity is situated either at the centre or on the surface of the bone. When it is central, the cavity is more or less rounded; sometimes it is anfractuous and has diverticuli. Its surface is usually smooth, but sometimes studded with needles of bone, which Nélaton compared to the papillæ of the tongue of a cat or tiger. Sometimes the walls are formed of "heterogeneous tissues, such as osseous, fibrous and cartilaginous." It is thus when the cavity has perforated the connecting

cartilage and extended to the diaphysis from the epiphysis, or conversely; or when it opens into a joint, passing through the articular cartilage; or when, finally, it destroys the cortical layer and appears and develops under the periosteum. In the last case, the process is accompanied by periostitis with more or less abundant periosteal bone-proliferation; and in case of penetration of a joint, an arthritis arises, sometimes acute, but more often fungous and chronic.

But the distinctive characteristic of encysted tubercle is the slight degree of reaction which it sets up around it, its course being so slow and sluggish, that it may not reveal itself by any symptom during life. On making sections of all the bones in autopsies, tubercles are sometimes met with (or cysts resulting from their spontaneous cure) in persons whom no one would suspect of being likely to present them. M. Ranvier has also made the remark that tuberculous granulations, even massed in islets, may occupy extensive areas of the medulla without it being possible to suspect their existence, except from a slight discoloration of the tissue; the microscope alone enables us to affirm their presence.

Around an encysted tubercle the bone-tissue usually presents only a very slight injection, describing a reddish circle two or three millimetres in width. In children the spongy tissue being red, this hyperæmic circle cannot be recognized. In the adult, as in children, the cavity does not contain any sequestrum, and is formed by the destruction, and not by displacement of the bone-tissue. The same is true, it will be understood, of the cartilaginous and fibrous tissues which the tubercle encounters in its development. The dimensions of the tubercle-cavity vary from five or six millimetres in diameter, up to two or three centimetres. Encysted tubercles are not generally seen in large numbers.

Encysted tubercle is not found only in the crude state; it may also be found softened. At the end of a variable time, sometimes several years, the mass becomes softened, without or with inflammation. In the latter case, the tuberculous matter will be found mixed with a greater or less number of pus-corpuscles and the peripheral irritation will be more considerable. May we not consider the forms of osteitis which are called neuralgic, or painful, to be tuberculous bone-abscesses of this kind, strangulated by the resistance of the walls of the cavity?

When a tuberculous abscess opens into a joint, it sets up a more or less acute arthritis; when it opens on the surface of the bone, it causes a collection of fluid under the periosteum, or under the aponeurosis, which insinuates itself in the cellular interstices of the organs, until it arrives under the integuments and perforates them. I have already spoken of the periostosis, which, according to Nélaton, in the extremities of the long bones opposes an ever-increasing barrier to the progress of an abscess on the side of the periosteum, and compels it to travel in the direction of the joint.

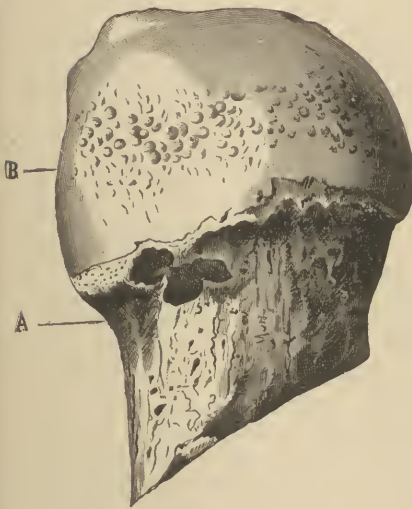
All osseous and tuberculous abscesses do not go on in this way until they burst externally. Non-inflammatory softening of the tuberculous material may be followed by its complete absorption. Sometimes there remains in the cavity nothing but limpid serum. Such is the etiology of some cysts in the bones. Ossifluent abscesses resulting from the softening of encysted tubercle do not always rupture; they may be absorbed and leave only a cord attached to the bone as a sign of their former presence. The classical type of ossifluent abscess is the abscess by congestion of Pott's disease of the spine. We know, from the researches of Volkmann and of Lannelongue, their mode of progress, which consists in successive invasion of the connective tissues by tubercle. The membrane is formed of proliferated and hardened connective tissue, it is crowded with tubercles which destroy it little by little as

they undergo caseation and soften, at the same time that a new layer of connective tissue is invaded and proliferates.

The encysted tubercle which we have studied in the crude, indolent state, and in the state of softening with ossifluent abscesses extending to the joints or not, may also be met with in the state of cicatrization and cure. I shall not refer again to cysts which are the residue of cured tubercles. I wish to speak now of a more common and also a more happy termination. Justifying the definition of Grancher: "an inflammatory neoplasm with a fibro-caseous tendency," encysted tubercle, after having voided its softened products, may become the seat of a connective-tissue proliferation, abundant and vigorous enough to fill the cavity with granulations, the tufts of which, purged of all tuberculous elements by inflammation, lose by degrees their rich vascularity, and are transformed into stable fibrous tissue. This is a mode of recovery by no means rare. It may be favored, in some cases, by approximation of the walls of the bone-cavity in consequence of a pathological spontaneous fracture, as occurs sometimes in Pott's disease, when the body of the vertebra has been reduced to a thin shell. So far from trying to hinder this form of fracture, it should therefore be favored and directed.

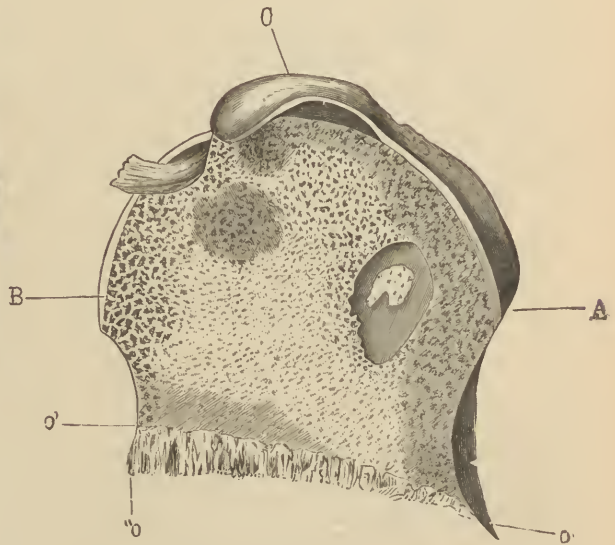
(2) *Tuberculous Infiltration of Nélaton; Confluent Granulations of Ranvier.*—"Some authors have had an imperfect idea of this form of tuberculous affection of bones, but none of them have described it." Nélaton, who wrote

Fig. 780.



Head of the femur after resection. B, diarthrodial cartilage showing multiple warty prominences. At the upper part is a more considerable elevation produced by fungating masses, which are well seen in the next figure. A, neck of the femur. Between the head and the neck is seen an excavation, which was filled with fungous masses, and which communicated with the central tubercle seen in the following figure.

Fig. 781.



Head of the femur, removed in a resection for suppurating coxalgia by Professor Ollier. A, articular cartilage, at c, elevated by fungous masses; B, rarefaction and medullization of the spongy tissue; D, D, foci of tuberculous osteitis of a yellow color; B, cavity of osteitis, containing a sequestrum surrounded by fungous growths; O, O', O'', splintered surface of bone below the line of section of the saw.

these words, admits however that Nichet, of Lyons, mentioned in some of his observations the presence of caseous matter in the spaces of the spongy

tissue. But Nichet did not describe tuberculous infiltration systematically, as Nélaton has done. This surgeon says that tuberculous infiltration may be met with alone or associated with the first form (encysted tubercle), but that it never follows it. It appears in two different states, which may be considered as two stages of the same form, and which may be designated by the names, *semi-transparent infiltration* and *puriform or opaque infiltration*.

Semi-transparent infiltration is characterized by the deposit of a gray, opaline material in the spaces of the spongy tissue, which appears as if invaded by a brain-like substance. In color these spots contrast sharply with the rest of the bone. A stream of water directed upon the spaces of the spongy tissue does not drive out the infiltrated material, which sticks tightly to the lamellæ of this tissue; a very slender bloodvessel passes through them and gives them a grayish-red color. The presence of the semi-transparent infiltrate brings about no modification in the density of the bone-tissue.

Puriform infiltration, on the other hand, which succeeds the semi-transparent infiltration, "is distinguished from the preceding: 1st, by the dull yellow color of the infiltrated portions of bone; 2d, by the absence of bloodvessels; 3d, by interstitial hypertrophy of the bone-tissue." (Nélaton.) The yellow material gradually undergoes softening and becomes puriform; whence its confusion with caries. The absence of bloodvessels is one of the facts which it is most important to note, says Nélaton. The hypertrophy of the bone does not extend to its whole mass; the lamellæ of the spongy tissue are alone hypertrophied, and sometimes to such an extent that the spaces which they circumscribe are almost entirely obliterated. Nevertheless there are some exceptions to this rule. The bones of the foot or hand may be infiltrated with tuberculous matter without undergoing eburnation. Nélaton explains this breaking of the rule by the rarefaction having existed before the infiltration. If the other bones of the tarsus and of the carpus are examined, he says, they will be found rarefied, although free from infiltration. This appears to be a somewhat specious explanation. For there is no proof of the priority of the rarefaction. We know, on the other hand, that the bones near a centre of chronic osteitis or arthritis become consecutively rarefied, in consequence of the disturbance of nutrition resulting from the disease, from immobility, from the pressure of dressings, etc. It is very possible that at the beginning there is interstitial hypertrophy, and that afterwards rarefaction supervenes. The succession of absorption to proliferation is a common occurrence in affections of the bones. Different anatomical, constitutional, or therapeutic conditions may hasten or retard the succession of these phenomena. To conclude, a pre-existent osteoporosis does not seem to me certain except in tuberculous infiltrations of the bones following fungous synovitis. Then caries is present, a lesion which I look upon as an osteopathy, probably tuberculous, but which was not so regarded by Nélaton. Nélaton does not believe that purulent infiltration is always preceded by semi-transparent infiltration; the infiltration may be of an opaque yellow color from the start. However this may be, "every tuberculous infiltration in a bone is a necrosis of the infiltrated tissue." (Nélaton.)

Necrosis is the consequence of the obliteration of the vessels by proliferation of the osseous substance of the lamellæ, in a word, by condensing osteitis. Around the portion of bone thus mortified by ischæmia, a zone of eliminating osteitis is formed, which isolates it and makes it a sequestrum, and this inflammatory process persists, in a continuous or intermittent manner, until the sequestrum is eliminated, spontaneously or by the aid of an operation, from its cavity, which is lined with granulations themselves more or less infiltrated with tuberculous products (Fig. 781). The isolation of the dead bone may sometimes be long delayed: "1st, Because," says Nélaton, "the

cause which in this case produces the necrosis acts with extreme slowness; 2d, because as the inflammation continues to propagate itself to the neighboring parts, the boundary between the healthy and the diseased portion is constantly receding, so that the circle of elimination cannot form." Nélaton says that two sequestra may wear each other away if they rub together. This must be a rare occurrence, and the loss of tissue of not much importance.

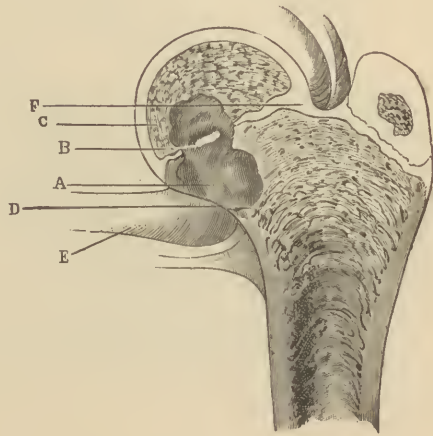
Puriform infiltration gives rise to *abscesses* which make their appearance either on the surface of the bones or at the joints. But it does not generally have as an accompaniment slow abscesses by congestion, like the encysted form. The description and the considerations, of which the formation, the course, and the termination of abscesses dependent upon encysted tubercle of bone have already been the subject, apply to abscesses from tuberculous infiltration, with this difference: that infiltration usually sets up a more acute and prompt reaction. Nevertheless it sometimes proceeds by slow steps, and may remain latent for a very long time. It may happen that the centres of infiltration are discovered only by accident, at an autopsy. This happened in the case of a child, four years old, who died of tuberculous meningitis at *La Charité*, where he had been admitted for a tibio-tarsal white swelling. M. Gangolphe, wishing to know if the patient had not tubercles in other bones than those of the foot, made sections of the whole skeleton, and found in the head of the left femur, which was apparently perfectly healthy, a tuberculous nodule which appeared to be on the point of opening into the joint, which was also still free from disease. I give in Fig. 782 a representation of this section.

In spite of the presence of a portion of dead bone which was beginning to be detached, there was as yet no articular involvement. The specimen presents also an interesting example of perforation by destruction of the epiphyseal cartilage.

We have seen that during the reign of dualism—the overturning of which is in great part due to M. Grancher, and partly also to MM. Thaon and Lépine—the tuberculous infiltration of Nélaton was regarded as a simple caseous osteitis. Even now there are still a certain number of opponents of his views, among whom is M. Gosselin. Cornil and Ranvier, to mention only the most classical histologists, admit them, with restrictions which have

not the significance at the present time, as far as caries is concerned, that they had ten years ago. In their view the tuberculous infiltration of Nélaton corresponds to various lesions: osteitis, caries, with caseous transformation of the medullary or purulent elements, and syphilitic gummata; but they recognize also a true tuberculous infiltration resulting from the presence in the bone-tissue of confluent tuberculous granulations. They describe these in the following way: Their size does not equal that of isolated granulations (less than from one to two millimetres in diameter),

Fig. 782.

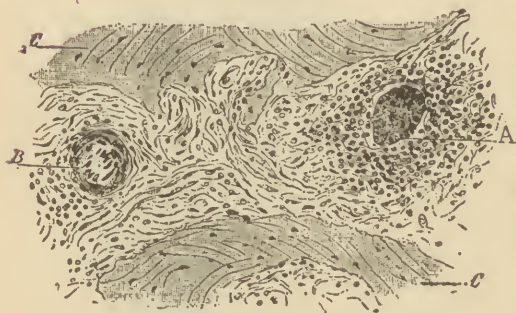


Tuberculous nodule with latent sequestrum of the head of the left femur. Child four years old. *A*, tuberculous sequestrum; *B*, fragment of the connecting cartilage, constituting part of the sequestrum; *C*, caseo-fibrous material surrounding the sequestrum; *D*, lamella of bone-tissue forming the wall about to give way on the side of the joint; *E*, capsule of the joint; *F*, connecting cartilage, a part of which constitutes part of the sequestrum.

they undergo caseous degeneration, obliterate the bloodvessels which they cross, and cause consecutively necrosis and caseation of the anæmic bone-tissue, or of the medulla, when this is surrounded with granulations. According to these authors, the sequestra are not due to condensing osteitis, as Nélaton believed, but to ischæmia of the parts. The confluent granulations may give rise to both forms of tuberculosis described by that surgeon. As to the hypertrophy of the bone-trabeculæ, so peculiar to infiltration, according to Nélaton, MM. Cornil and Ranvier say that usually they undergo neither condensation nor rarefaction. They also call attention to the fact, that the caseous melting down of the medulla does not extend to the bone-corpuscles, the nuclei of which become irregular in outline, it is true, but are not surrounded by fatty granulations; a characteristic which, they say, "permits the caseous transformation which supervenes upon confluent tubercles to be distinguished from that which accompanies caries."¹

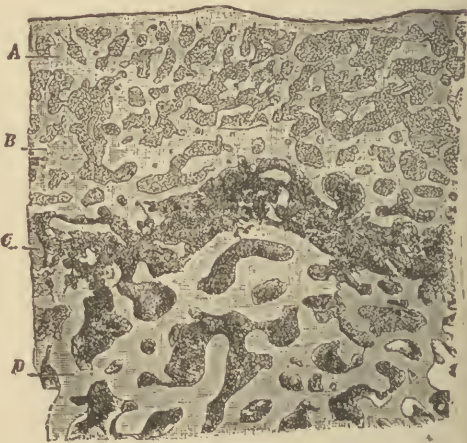
Quite recently MM. Kiener and Poulet have taken up this study, with the modern views.² They have demonstrated the presence of the tuberculous follicle in the depths of the bone-tissue. In their preparations one may follow the whole course of follicular development. The cells of the inner wall of the capillaries of the diseased region hypertrophy, undergo hyaline degeneration, run together, and end in the formation of a giant-cell which fills the

Fig. 783.



Section of a tuberculous bone. A, tuberculous follicle; B, section of a vessel, in which is seen hypertrophy of the endothelial cells; C, trabeculæ of bone. (After Charles Nélaton.)

Fig. 784.



Section through the periphery of a patch of tuberculous infiltration. A, sub-periosteal layer of bone dependent on distant irritation. Sometimes it is very thick, and forms a true shell around the sequestrum. This is seen, especially in children, in the region of the phalanges (*spina ventosa*); B, old bone; C, ridge of eliminative rarefying osteitis, separating the infiltrated and necrosed part from the normal tissue; D, the sequestrum with its hypertrophied trabeculæ. (After Charles Nélaton.)

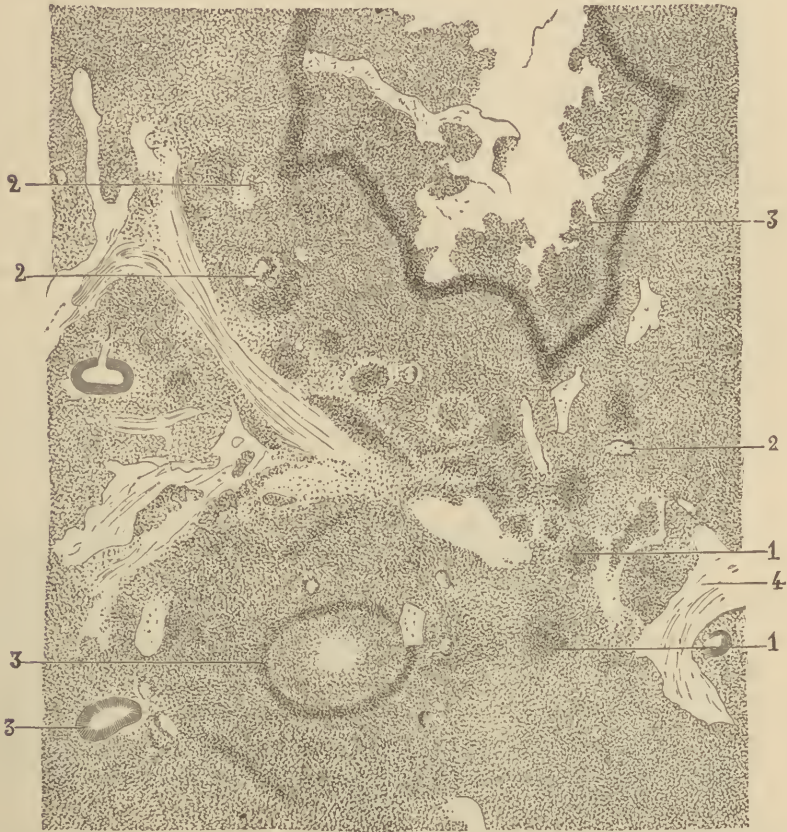
capillary. The pathological irritation exerting its influence also on the other tunics of the vessels, the latter are infiltrated with epithelioid cells, and with embryonic vessels. The follicle is then formed, and the vessel is closed. (Fig. 783.) I give here some of the drawings of these authors. In Fig. 784, M.

¹ Cornil et Ranvier, *Manual d'Histologie Path.*, 1869.

² Kiener et Poulet, *Archives de Physiologie*, 1880.

Kiener has represented a section from the periphery of a patch of tuberculous infiltration. Fig. 785 represents a section of diffused tuberculous infiltration, designated by MM. Kiener and Poulet under the name of acute tuberculous osteitis.

Fig. 785.



Diffuse infiltration, acute tuberculous osteitis of MM. Kiener and Poulet. 1, tuberculous follicles; 2, giant-cells scattered through the proliferated cellular tissue; 3, cavities caused by caseous breaking-down of the follicles; 4, rarefied bone-tissue.

The sequestrum does not always show hypertrophy; in some cases its trabeculae are thinned. M. Kiener has studied the histological conditions of condensation and rarefaction. In his opinion the proliferation of bone is precluded by the appearance of osteoblasts upon the trabeculae, as in normal growth. Around these osteoblasts there is deposited bone-material, sometimes in continuous layers, sometimes in small protuberances. At still other times, the bone-material is deposited between the fibres of the connective tissue furnished by medullary proliferation. Rarefaction is brought about in two ways; sometimes, as in the formation of a lacuna of Howship, the edges of the trabeculae are furrowed by small fossae with regular outlines. The work of wearing away is caused by the giant-cells—by osteoclasts, according to the expression of Kölliker—which owe their origin to a functional and anatomical transformation of the osteoblasts, according to M. Julius Busch (*osteoblasty*). Sometimes the rarefaction results from solution of the calcareous cement and return of the bone-substance to the fibrous state. It is well known that Charles Robin attributed the density of the sequestrum, not

to a new formation of bone, but to a simple accumulation of calcareous salts in the areolæ of the spongy tissue and in the canals of Havers. According to Lannelongue, the hypertrophy of the sequestra is apparent only; they lose their compactness by remaining in pus or in the liquids of the cavities which contain them.

(3) *Disseminated Tuberculosis*.—In some cases there has been observed a sort of general granulation of the skeleton. In all the bones there are seen, in the midst of the marrow of the spongy tissue or of the medullary canal, tuberculous granulations in variable numbers. Isolated tuberculous granulations are, according to M. Ranvier, quite frequent in the skeleton of the phthisical. Examining the bones of persons who had died of phthisis without any apparent evidence of tubercle of the bones, Ranvier found, six times out of twenty, granulations in the adult. I am convinced that a similar investigation in children would be even oftener rewarded with success. It is probable that, among the many cases of juxta-epiphyseal osteitis following grave pyrexias, a certain number are of tuberculous origin—are cases of osseous granuloma. Here is an open field for investigation. M. Parrot has published a case of miliary tuberculosis.

Inoculability and Parasitic Nature of Tuberculous Osteopathies.—After having shown the presence of the different histological forms of tuberculosis in the osteopathies called tuberculous, it remains, in order to complete this chapter on pathological anatomy, to prove that they are also inoculable and parasitic. The *inoculability* of the products of bone-tuberculosis is demonstrated by the experiments of Schuller, Volkmann, Hueter, König, and others. M. Ollier, in 1873, caused the successful inoculation, in the laboratory of M. Chauveau,¹ of fungous material from the joints. But I ought to mention particularly the experiments of MM. Kiener and Poulet, which have been published, to the number of ten, by M. Charles Nélaton.² In all cases of inoculation of the products of tuberculous bone-lesions, generalization has taken place, and the histological manifestations of tuberculosis have been reproduced in the infected animal.

The presence of a *parasite* in these osteopathies is no longer a matter of doubt. MM. Schuchardt and Fedor Krause³ looked for it for a month in all the cases which came into the clinique of Prof. Volkmann. "The presence of the tubercle-bacillus," they say, "has been established in forty cases of tuberculosis of the bones, joints, etc. We have determined with certainty that in all cases of surgical tuberculosis it is as easy to discover the bacillus tuberculosis with the microscope, as in the sputa of the tuberculous or in the nodules of acute miliary tuberculosis." There were not usually a large number of bacilli discovered, because in none of the cases examined was the lesion found in the stage of onset, the time at which the bacilli are probably most numerous and easiest to recognize. Here is a whole world to explore. (See general remarks upon tuberculosis, p. 803 *et seq.*)

II. OSTEOPATHIES WHICH ARE PROBABLY TUBERCULOUS.—I wish to speak here especially of caries and of spina ventosa.

(1) *Caries*.—M. Ollier in his authoritative article has thus defined caries:⁴ a chronic, suppurative inflammation of the bone-tissue, with a slow course, and usually progressive, without any distinct tendency to recovery, developed under the influence of an internal cause, characterized by retrograde processes which accompany the inflammatory processes, induce suppuration, and bring

¹ Roux, *Arthrite tuberculeuse*. (Thèse.) Paris, 1875.

² *Le tubercle dans les affections chirurgicales*. (Thèse d'agrégation.) Paris, 1883.

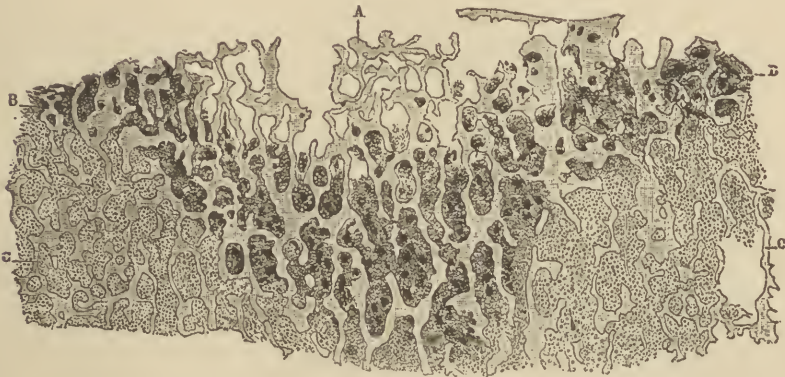
³ *Fortschritte der Medizin*, von K. Friedländer, Bd. i., No. 9.

⁴ *Dictionnaire Encyclopédique*, etc.

on successive destruction of the parts involved, either in the shape of necrosed fragments or in the shape of more or less voluminous sequestra. This affection may then be considered as an ulcerating osteitis, in this sense: that ulceration or disintegration of the portions of bone attacked by necrobiosis is its most prominent phenomenon." M. Ranvier had given, as the characteristic sign of caries, pre-existing granulo-fatty degeneration of the bone-corpuscles. M. Ollier demonstrated that these alterations of the corpuscles were consecutive and not pre-existent to the inflammation of the bone-tissue. There is nothing to be changed in the remarkable description of caries which M. Ollier has given. The question of its nature can alone be presented in a different way. I shall confine myself to presenting the arguments which at the present time seem to favor connecting caries with osseous tuberculosis, and its admission to the number of those affections of the bones to which I propose to give the name of tuberculous osteopathies.

The differential sign derived from the rarefaction or eburnation of the tissue of sequestra has no value, as we have already seen. If the sequestrum is porous in caries, this depends on the fact that the disease has developed upon prepared soil, one already rarefied. Caries almost always shows itself in the articular extremities of bones, in consequence of a chronic affection of

Fig. 786.



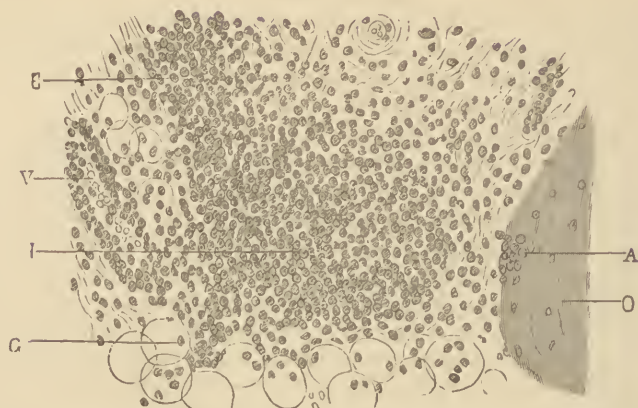
Section showing the lesions of caries. *A*, trabeculae of bone bathed in pus which has flowed out, leaving them bare; *D*, *B*, zone of tuberculous infiltration, the trabeculae are slightly condensed; *C*, *C*, rarefied and hyperæmic bone-tissue. (After Ch. Nélaton)

the corresponding joint. The wasting influence of this inflammation, as well as the immobilization of the limb demanded by pain or by treatment, causes simple rarefaction, or rarefaction with hyperæmia of the epiphyses. This rarefaction explains at the same time the tendency to diffusion of the tuberculous principle in caries, and the porous condition of its sequestra, which preserve a certain vitality in the midst of the fungous tissue which surrounds and penetrates them.¹ The clinical course and the macroscopic lesions being the same in caries and in tuberculous affections of the bones, we must look to histology and to experimentation for proofs of the tuberculous nature of the former. Histology has discovered tuberculous nodules in caries. Here is a microscopic preparation (Fig. 787), borrowed from M. Dubar.²

¹ Ollier, *Vascularité des séquestres* (Dict. Encycl., etc., Art. Carie); *Traité de la Régénération des Os*.

² Op. cit.

Fig. 787.



Caries. O, bone attacked with rarefying osteitis; A, lacuna of Howship; I, tuberculous nodule with vitreous condition of the centre; V, vessels; E, network of embryonic tissue; G, adipose vesicles. (After Dubar.)

MM. Kiener and Poulet have found tuberculous follicles in large numbers in the sequestra of caries, in the fungous masses within and in the walls of the cavities which contain them.

Inoculation furnishes a complement to these proofs which is of considerable significance; animals have been successfully rendered tuberculous by inoculating them with fungous material from caries, stuffed with follicles. (Volkman, Lannelongue, Kiener.) The parasite has been met with in caries; not always however. M. Cornil, who has examined fungous masses obtained from carious bone, has failed to find the bacillus in a certain number of cases.¹

It is possible that the parasite may be a different one, and that, in looking for the bacillus, the special micro-organism of caries has not been seen. This point requires further investigation. But we may conclude even now, from what is admitted, that caries is a tuberculous affection of the bones grafted upon a chronic rarefying osteitis.

(2) *Spina Ventosa*.—Nélaton considered spina ventosa as a disease of tuberculous nature, and his view has been adopted by A. Bérard, Vidal (de Cassis), and Virchow. Goetz² denies its tuberculous origin, and declares, with Volkman, that the first occurrence is a slow inflammation of the medulla, a chronic medullitis, characterized by a fungous state of the medulla, and that there occurs secondarily a rarefying osteitis, and then a periostitis. According to M. Parrot,³ the lesion is tuberculous. Its point of departure lies in gray nodules, which are identical with the tuberculous granulations of the lungs and other viscera.

In all the cases studied by Parrot, organic tuberculosis was found: ulcers of the lungs and of the intestines. M. Lannelongue also admits the tuberculous origin of spina ventosa; he has found the medullary tissue and the fungous masses infiltrated with tuberculous follicles, as well as the walls of the ossifluent abscesses which proceed from them. M. Heydenreich,⁴ who does not consider the presence of the tuberculous follicle as sufficient to characterize tuberculosis, confesses, nevertheless, that the appearance of the lesion at its commencement, its ultimate course, and the results of histological examination, all appear to agree in justifying the opinion which sees in spina ventosa a tuberculous affection.

¹ Dubar, op. cit. p. 99.

³ Gaz. Méd. de Paris, 1880.

⁴ Dictionnaire Encyclopédique, etc. (Art. Pathologie des os, p. 341.)

² Étude sur le spina ventosa. (Thèse.) Paris, 1877.

For my own part, I believe that there are two kinds of spina ventosa: one osseous, central, medullary; the other peripheral, periosteal; and that spina ventosa is always of tuberculous nature. The development of tuberculous follicles in different points of the medulla (the central canal of the bone, the areolæ of the spongy tissue, the Haversian canals of the compact tissue, the osteogenic layer of Ollier or sub-periosteal medulla of Ranvier) gives rise to the clinical varieties of this disease in cachectic patients.

The more we advance in the study of diseases of the bones, the more we see the ill effects of tuberculosis multiply. I am persuaded that the greater number of cases of periostitis and osteo-periostitis, in children and in cachectic adults or old people, are caused by deposits of tuberculigenous parasites, and by their evolution, which varies according to their peculiar nature, the soil invaded, and the part of the soil in which they collect and remain. I desire no other proof of this than the inoculations of MM. Kiener and Poulet, who have obtained generalizations of tubercle by injecting pus and fungous granulations obtained from a suppurating osteo-periostitis of the fourth and fifth metacarpal bones, from a periostitis of the ribs, and from a periostitis of the great toe.¹

I shall consider the macroscopic appearances of spina ventosa hereafter.

SEAT OF TUBERCULOUS OSTEOPATHIES; CORRELATION WITH THE LAWS OF GROWTH.—I have already said that strumo-tuberculous osteopathies are usually situated in the spongy tissue of the bones which have red marrow; the sternum, the ribs, the bodies of the vertebræ. (Ranvier.)

Nélaton classifies the bones as follows, in regard to the relative frequency of their tuberculous affections: 1st, vertebræ; 2d, tibia, femur, humerus; 3d, phalanges, metatarsal bones, metacarpal bones; 4th, sternum, ribs, ilium; 5th, short bones of the tarsus and carpus; 6th, petrous apophysis of the temporal bone. The bones which are not mentioned in this enumeration may be classed with those with which they have the greatest analogy in shape and structure.

Nélaton thinks that tubercles occur more frequently in the bony epiphyseal nucleus than in the expanded extremity of the diaphysis. This may be true of caries following chronic arthritis, and sometimes of encysted tubercle, but in a general way the proposition is not exact, as we shall presently see.

M. Heydenreich, after having remarked that tubercles originate in the centre of the bone-tissue rather than on its surface, adds: "In the long bones, tubercles have a predilection for one of the extremities: in the femur, the lower extremity is oftener affected than the upper; the contrary is the case with the tibia; in the humerus and in the bones of the forearm the extremity most frequently diseased is that which is near the elbow."

Nothing could be more true; but what is the reason? The laws established by M. Ollier in regard to the growth of the long bones, in regard to the respective part played by each extremity of the bones in this growth, alone account for the elective localization of morbid processes in the bones. He has demonstrated² that the long bones increase principally on the diaphyseal side of their connecting cartilage, and that, in the same bone, both connecting cartilages do not take an equal part in its growth; the tibia grows chiefly by its upper end; the femur by its lower end; the humerus by its upper end; the radius by its lower end, etc. He has shown, besides, that morbid processes, neoplastic or inflammatory, are implanted where physiological life is most active; that they ought to choose, and do choose by preference, the parts of the bone which contribute most to their growth.

Clinical experience verifies every day the justness of these principles,

¹ Charles Nélaton, Thèse, p. 127.

² Ollier, *Traité Expér. et Clin. de la Régénération des Os*.

which throw a most valuable light upon the whole subject of osseous pathology. "I long since demonstrated," says M. Ollier,¹ "that in childhood and adolescence, in other words, during the whole period of growth of the skeleton, the juxta-epiphyseal portions of the shafts of the long bones, that is to say, the terminal portions of their diaphyses, were most frequently the seat of the various acute or chronic inflammations, and, in general, of the different neoplasias whatever their nature. The greater nutritive activity of these portions of bone, during all the period of formation, explains their proneness to become the seat of morbid processes. It is by the extremities of the diaphysis that the bone grows, it is here that occur transformation of the layer of cartilage and development of osteoblasts, and finally the formation of the very vascular spongy tissue; in this very vascular spongy tissue also is expended the force of blows, of exaggerated compressions, and of articular distentions, and in it tuberculous neoplasias are preferably manifested."

"These affections of the bones are usually, in children, the origin of affections of the joints. . . . The invasion of the joint is dependent upon the relation of the synovial membrane to the juxta-epiphyseal region. In the shoulder, in the ankle, in the wrist, osteitis remains for a long time isolated; but in the hip, whenever a centre of osteitis, tuberculous or otherwise, is developed in the neck of the femur, there is soon an invasion of the joint, for the neck, the upper extremity of the diaphysis, lies within the joint itself."

M. Ollier does not deny the formation of tuberculous centres in the epiphyses; for he says: "The epiphyses are themselves the seat of these centres of primary osseous inflammation, but less often than the juxta-epiphyseal portions of the diaphyses. Nutritive activity is much less pronounced in the epiphyses than in the corresponding parts of the diaphysis." M. Ollier admits, with M. Volkmann, that a large number of cases of arthritis are of osteopathic origin. But he believes that primary tuberculous synovitis is much more frequent in adults than is acknowledged by the eminent surgeon of Halle.

The laws of growth apply equally to the flat and short bones. The parts bordering on their cartilages of growth are also the most exposed to tuberculous or other spontaneous inflammations (calcaneum, ilium).

In all the bones, the tuberculous affection may not produce any marked effects, or it may give rise to inflammation, to sessile or pedunculated abscesses, to periosteal hyperostoses, to more or less invaginated sequestra, to arthritis, etc.

I ought to mention some peculiarities of certain bones. In the flat bones, tuberculous lesions have a tendency to assume an ulcerating character; the bones may even be completely perforated. (Lamelongue.) The iliac bone quite often shows these perforations. They are also seen in the cranium. Rilliet and Barthéz have reported a series of cases of tubercle developed upon the vault of the cranium, upon the upper wall of the orbit, in the sphenoid, the ethmoid, the mastoid process, and finally in the petrous bone. Recently Volkmann² has described a lesion of the vault of the cranium which he considers tuberculous, and designates by the name of *perforating tuberculosis of the vault of the cranium*. He has seen it twelve times in the frontal or parietal bones. Limited to a single part of the cranium, never exceeding in extent the size of a *franc* piece, it is characterized by caseous degeneration followed by suppuration, by separation of the periosteum and of the dura mater, and by necrosis of the bone in its whole thickness. I question if these were not cases of syphilis rather than of tuberculosis. Kraske,³ on the other hand, has related two cases of Reid's, where the tuberculous lesion of the cranium was multiple, and accompanied by tuberculous lesions in almost all

¹ De la résection de la hanche (Revue de Chirurgie, Mai, 1881, p. 383).

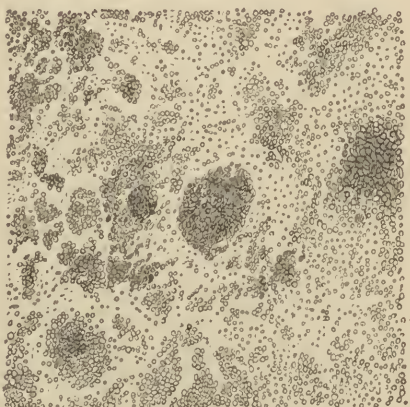
² Centralblatt f. Chir., 1880. No. 1.

³ Ibid., No. 19.

of the organs—a circumstance altogether in favor of the tuberculous nature of the process.

Tuberculosis of the phalanges, and of the metacarpal and metatarsal bones, assumes, on account of its situation, an altogether peculiar form, which is suggested by the name *spina ventosa* which has been applied to it. *Spina* calls up the idea of the pain which is compared to that of the pricking of a thorn; *ventosa* indicates the blown-up appearance of the bone. The pain is sometimes absent, the swelling is constant. The fusiform swelling of the bone is due, either to the collection of pus under the periosteal sheath which is detached in its whole length, and attached to the bones by its two ends alone, or to subperiosteal bone-formations, the bulging shape of which is due to the same conditions of the periosteum. One of the most curious peculiarities of this tuberculous osteitis, is that, while new layers of bone are being laid down on the periphery, the old bone empties itself from within outwards, until it hollows out for itself a large cavity, full of fungous and gelatinous marrow, crowded with tuberculous elements. There may be also some points of suppurating periostitis in this bony form of *spina ventosa*, and it is at these points, where the periosteum is destroyed, that sequestra are seen to form, and afterwards perforations, leading to the central canal. Ossifying or suppurating periostitis outside, rarefying osteitis inside, such is the double morbid action which characterizes ordinary *spina ventosa*. Islets of the spongy tissue, and even of the diaphysis, may become necrosed, either by suppurative destruction of the periosteum, or from the more rapid invasion of the micro-organisms at certain points, or from both causes at once. Sometimes extensive sequestra are formed. Usually the joints are not affected; and usually, also, the shell of periostosis finally becomes perforated, when abscesses soon form openings in the skin which give vent to pus and to fungous masses coming from the centre of the bone, and which permit its exploration. *Spina ventosa* is most frequently met with in the hand, especially in the middle finger (the first phalanx) and its metacarpal bone. In the foot, the first metatarsal bone is oftenest attacked. Parrot and Volkmann, in exceptional cases, have seen *spina ventosa* in the ulna. It is also exceptional to see this affection of the bones in adults and old persons, but I have, in one week, seen two exceptions of the sort. One in a woman sixty years old, who had an ulcerated *spina ventosa* of the first phalanx of the right ring-finger, so fungating that I had to amputate it; the other in a man thirty years old, who has a *spina ventosa* of the first phalanx of the right middle finger, with slight involvement of the joint between the first phalanx and the second, and a painful point on the anterior surface, where spontaneous opening is likely to occur. It is to be remarked that in both cases the course has been slow; for, in both patients, the *spina ventosa* has lasted almost two years. M. Lannelongue refers to tuberculous gummata (Brisaud and Josias) on the arms of children affected with *spina ventosa*. It is reasonable to suppose that dissemination of the tuberculous material, the micro-organisms, has taken place by way of the lymphatics. Tuberculous

Fig. 788.



Tuberculous adenitis following an osteo-arthritis of the same nature.

affections of the joints and of the bones being entirely analogous, it is proper to say here, in support of the hypothesis of this mode of propagation, that, in an autopsy made at the clinique of M. Ollier, it was possible to trace the tuberculous infiltration of the lymphatic system even to the pelvic ganglia, after a white swelling of the ankle. M. Gangolphe, chief of the clinique, following up this subject, has collected a large number of cases of tuberculous osteo-arthritis in which the swollen efferent ganglia were found to be tuberculous. He believes that, in the generality of cases, adenitis following fungous articular or osseous lesions has this specific character. He has recently had a new opportunity to verify this remark, in a woman for whom I amputated a thigh for a white swelling of the knee. At the dissection of the limb I found a small popliteal ganglion, which nevertheless disclosed the same tuberculous elements as the fungus of the knee, and quite typical, as may be seen in the preceding illustration (Fig. 788), which I owe to the pencil of M. Mondan, from a preparation of M. Gangolphe.

ETIOLOGY OF TUBERCULO-SCROFULOUS OSTEOPATHIES.—The general causes which give rise to tuberculosis of the bones are those of the diathesis itself. Contagion, hereditary predisposition, and physiological weakness, constitute the etiology common to both external and internal tuberculosis. They need not be considered here. We shall study only the part of traumatism in the production of tuberculous outbreaks in the bones. The experiments of Schuller are well known. After having rendered animals tuberculous by means of injections of tuberculous material, Schuller inflicted various traumatisms upon their joints. In his experiments he saw fungous arthritis developed, with swelling of the extremities of the bones, enlargement and vascularization of the areolæ of the spongy tissue, and sometimes suppuration. The same traumatisms, inflicted upon animals which had not been inoculated, caused only effusions of blood, the absorption of which took place in the space of eight days. These experiments prove the influence of traumatism in subjects rendered tuberculous. Clinical experience had for a long time indicated that contusions and strains were often the cause of white swelling in the scrofulous, in persons predisposed to tuberculosis or manifestly under the influence of the diathesis. M. Ollier has been led, by clinical observation and by experimentation, to describe a *juxta-epiphyseal strain* in children, a name by which he designates the whole array of lesions produced in the juxta-epiphyseal regions of the diaphyses of the long bones by violent movements of the joints. This kind of strain, hitherto but little understood, is more common than is generally believed, and is the point of departure in many cases of osteitis in childhood and adolescence, in patients who are ill-cared for or predisposed. This observation is full of instruction. One must not treat lightly blows and articular strains, which, in children, leave pain in the epiphyseal regions. For the traumatism, if not recognized or if misunderstood, may be the exciting cause of tuberculous localization. The following is the way in which M. Ollier expresses himself on this point: “Juxta-epiphyseal strain is usually without gravity, and amounts to no more than a painful indisposition to motion which soon disappears of itself. But if the child be not taken care of, and if it be scrofulous, or hereditarily predisposed to tuberculosis, juxta-epiphyseal strain may be a frequent cause of rapid or slow osteo-myelitis, dependent on the giving way and trabecular fracture of the spongy tissue. All forms of osteo-myelitis may be the consequence of the lesions of juxta-epiphyseal strain.”¹ It is moreover, as far as tuberculosis

¹ Ollier, De l'entorse juxta-épiphyseaire et de ses conséquences immédiates ou éloignées, au point de vue de l'inflammation des os. (Revue de Chirurgie, Oct. 1881, p. 809.)

is concerned, a general fact, and one well known at the present time, that the bacilli, which remain inoffensive, even in incalculable numbers, in healthy tissues, precipitate themselves immediately upon these same tissues as soon as they are changed by inflammation, this making them a favorable medium for culture.¹ The part of traumatism is therefore incontestable in the etiology of tuberculous affections of the bones; but it must not be exaggerated, nor must all tuberculous osteopathies be attributed to a traumatic cause.

In the preceding pages I have recalled, and appealed to, the law so justly established by M. Ollier, the law of the relation of morbid processes to the physiological activity of the cartilages of growth. It is well to add here, that traumatism effects some modifications in the clinical expression of this law, at least in inflammatory lesions.

Thus, for example, in the humerus, the upper end ought to present more inflammatory lesions than the lower end, since it contributes most to the lengthening of the bone. But, in practice, the lower end of the humerus is most frequently found diseased, either primarily or consecutively to an affection of the elbow. This depends upon the superficial position of this extremity, which exposes it to daily traumatisms, and upon the fact that the upper extremity is protected against these causes by its position, and by the thickness of the muscular covering which surrounds the scapulo-humeral region.

Age.—Tuberculous osteopathies are most common in childhood and adolescence. When they are met with in adults or old persons, they are usually relapses, or have been preceded, at a former time, by osteitis of the same nature, in other parts. Old persons with osteopathies are ordinarily persons who have relapsed. Nevertheless, scrofulo-tuberculous osteopathies are sometimes seen to appear for the first time in cachectic old persons. I have under observation, at the present time, two such cases, in patients who until now have had no disease of the bone. It is possible to become tuberculous at any age: through the bones, the skin, or the viscera. It is only necessary to offer, at any time, a suitable soil for the evolution of the parasites of tuberculosis.

Climate.—It is generally recognized that, if cold and wet climates are especially rich in scrofulo-tuberculous osteopathies, in all latitudes, yet the great centres of population and poverty furnish a considerable contingent to the statistics of this common disease of the skeleton.

SYMPTOMS AND DIAGNOSIS.—There are no symptoms peculiar to tuberculous affections of the bones, no pathognomonic signs. There may be a strong presumption that tuberculosis of the bones is present, after a thorough examination of all the conditions of the patient; but no absolute sign indicates it, unless perchance a sequestrum spontaneously eliminated has been secured and examined by the microscope, or exploration has permitted the collection of some portions of a fungous growth which the microscope has shown to be tuberculous. Except in these cases, the symptomatology gives only probabilities—up to the present time at least.

Examination of the products of suppuration in diseases of the bones, and the examination of the blood of patients and of their excretions, might, by disclosing the presence of bacilli, the specific parasites, give a pathognomonic means of diagnosis, if such a method were clinically practicable. Clinical observation enters upon this road full of the most legitimate hopes. Ferguson has made a collection of statistics, the result of which is that, out of a total of 2509 cases of phthisis, in which search was made for bacilli (most

¹ Bacilles de la tuberculose. (Revue de Médecine, Sept. 1883, p. 782.)

frequently in the sputa), they were found 2417 times. R. C. Smith has found bacilli in the pus of an abscess at the margin of the anus in a phthisical person, and Shingleton Smith in the urine of a tuberculous patient. Bacilli have also been found in the blood and in the expired air of consumptives.¹

Inoculations in series of the blood, of the fluids of the economy, and especially of the products of osteitis, might also constitute an absolutely certain means of diagnosis; but unfortunately this plan has the drawback of demanding too much time.

By what signs shall encysted tubercle be recognized? As long as it remains in a crude state, and does not soften, its existence is not revealed by any symptom, because it does not excite any noticeable inflammation around it. At autopsies, latent tubercles are sometimes met with in the same bones which have presented phenomena necessitating either amputation or resection. Thus, for example, on section of the femur, a latent tubercle may be discovered in its lower extremity, when its upper extremity had manifested acute tuberculous osteitis. That is to say, some encysted tubercles may remain latent an indefinite time, while others promptly reach their stage of softening and of inflammatory reaction. Where the latter are present, the patient complains of more or less severe, deep-seated pain, which is increased by walking, by motion, and by pressure. In the superficial bones, like the tibia, for example, the pain is so acute that the lightest touch evokes cries from the patient. On the other hand, the process may sometimes pursue its entire course in the bodies of the vertebræ without being accompanied by any notable pain. When an abscess is formed in one of the bones of the limbs, the part swells up at this point, the skin becomes red and shining, rigors and fever appear, or not, according as the abscess is chronic or acute, and finally, when opened spontaneously or otherwise, this gives exit to ill-formed pus, bringing with it grumous masses of yellow caseous matter. The succession of these phenomena varies in rapidity, according to a number of causes; perhaps the kind, number, and virulence of the parasites, and certainly the general condition, the rest maintained, and the care received. The route by which the pus escapes remains fistulous, until the tuberculous cavity is emptied of its original contents, and filled with a healthy crop of granulations. The organization of the latter is usually delayed, because it is hindered, on the one hand, by the tuberculous granulations which still infect the cavity, and, on the other hand, by the rigidity of its walls. This furnishes an indication to clear these cavities from all tuberculous products, if they are accessible, and to stimulate them, so as to obtain an abundant crop of good granulations. The probe introduced into these cavities generally encounters no sequestrum, or only a few fragments of dead bone, which keep up suppuration until they come away. The abscesses which result from the breaking down of an encysted tubercle do not all open externally. If, instead of being situated in the superficial layers, they occupy the central part of the end of the bone, they often open into the neighboring joint. This course of events should be thought of when the surgeon finds himself in the presence of an acute, subacute, or fungous arthritis which has been preceded by well-marked pain and swelling at the expansion of the diaphysis and epiphysis of the bones making up the joint. I have already said that encysted tubercles situated in the bodies of the vertebræ give rise to so-called abscesses by congestion. I think that painful neuralgic osteitis may be only encysted tubercle in process of softening, and only accompanied by such intense, strangulating pain, because deeply situated in a tissue naturally more compact than the spongy tissue, or which has become so by surround-

¹ Revue de Méd., Sept. 1883, p. 783.

ing sclerosis. Furthermore, these neuralgic forms of osteitis are found only in patients whose general condition is bad or suspicious.

The symptoms of *tuberculous infiltration* resemble somewhat those of softened and inflamed encysted tubercle. Here the phenomena of necrosis and sequestrum predominate. The course is more rapid, especially in acute infiltration, and the symptoms of eliminative reaction are more accentuated in intensity and in extent. The probe generally falls upon a sequestrum, giving a clearly defined sound, but less dry, less shrill, because of the surrounding fungous masses, than that which it gives in striking against a sequestrum of phlegmonous periostitis. Multiplied and recurring abscesses, with fistulous tracks, are still more common in tuberculous infiltration than in encysted tubercle. Suppuration is brought on by the presence of one or more sequestra. The process being diffused and continuing to progress, while the parts which die first are being isolated by rarefying suppurative osteitis, other parts, if the general condition does not improve, are being invaded, die in their turn, and give rise to a new outbreak of eliminative osteitis.

Inflammation unceasingly relighted furnishes unceasingly to the bacilli the conditions necessary for their indefinite generation. Hence the persistence of these centres of suppuration, lasting for years, sometimes for a lifetime. We see every day adult or adolescent patients come into our wards, with suppurating osteitis dating back four, five, and ten years, and cases have been reported of still longer duration. I have operated upon a young man who had had for fourteen years a suppurating centre of fungous, juxta-epiphyseal osteitis.

In cases in which *caries* follows fungous synovitis, its symptoms are mingled with those of white swelling. The articular extremities are swollen by œdema and by proliferation of the soft parts; movement of the joints gives the characteristic crepitus which results from rubbing together denuded bone-surfaces. The fistulæ lead down to rugous and friable surfaces, or to a layer of fungosities which must be passed through before the bone is reached. The tearing of the fungosities always causes a slight bleeding in these explorations. The probe often meets with detached particles, or more or less voluminous sequestra, in the midst of these fungosities. These sequestra have the peculiarity, that they are light and porous, because caries, as I have said, succeeds an arthritis or a fungous synovitis which, by rest, by inaction, or by vascular or nutritive disturbances, has caused fatty rarefaction of the epiphyses or even of the entire bone.

The sequestra of caries have their peripheral alveoli filled with fungosities which connect them with the fungosities of the cavity in which they are contained, and they preserve by this means a certain degree of vitality, to which they owe the power of becoming again medullized, of diminishing in size, and even of disappearing. The probe also reveals diminution of resistance in carious bone-tissue which is not yet dead nor formed into a sequestrum. By pushing it in with moderate force there is obtained a parchment-like crackling, which results from the breaking of the thinned osseous trabeculæ. (Billroth and other authors.)

The formation of abscesses and fistulous tracks presents nothing to be particularly noted in tuberculosis of the bones. Sclerosis and periosteal hyperostosis may often be observed around a patch of caries which is on the road to recovery, but to a less degree than in simple tuberculous infiltration with an acute or subacute course. The swelling of the limb seen in caries, at the level of the diseased part, is due rather to inflammatory œdema than to bone-proliferation caused by irritation of the periosteum at a distance. A certain part of the apparent swelling must be attributed to wasting of the limb above and below, by atrophy of the muscles which are condemned to inaction.

Caries has an indefinitely progressive course, if it be let alone. Nevertheless, in children, caries may be spontaneously cured after elimination of the sequestra and transformation of the fungosities, under the influence of a better alimentation. M. Ollier speaks of the possibility of the recovery of caries by the absorption of the necrobiotic and even purulent products, especially in young patients.

Volkmann has described, under the name of *dry caries*, a bone lesion which he has seen in the flat bones and also in the long bones, especially at the upper end of the humerus. It leads to perforation of the flat bones; and when it is seated in the diaphyses of the long bones it may bring about a true solution of continuity of the bone, a spontaneous pseudarthrosis.

"Instead of the luxuriant tissue of deep red, or œdematous and quivering granulations, which is ordinarily seen, and which leads to destruction of the subjacent bones, there is found a moderately thick layer of a tissue which is very deficient in vessels and almost cartilaginous, and which adheres closely to the bone-tissue. What is especially characteristic of dry caries, is that at a very early period the articular cavity is obliterated by the limited and dry granulation-tissue which, starting from the synovial membrane, extends between the bony surfaces and causes them to adhere together. The process is essentially local; there is absolutely no lardaceous thickening or production of osteophytes. Atrophy of the bone and deformity of the joint are the true characteristics of this affection. There is ordinarily neither suppuration nor fever; spontaneous pain is also rare. The general health remains excellent."

I do not know what to think of this caries which reveals itself neither by pain nor by abscesses. I should not be surprised if histology should some day place it among tuberculous affections. It may be a sort of indolent tuberculosis tending to sclerosis of the vegetations without provoking suppuration. Its parasite is perhaps not the same, or it may be found in peculiar conditions. M. Ollier, who has seen some cases of this kind, expresses himself in regard to them in the following manner, in his article on *caries*: "But these lesions do not appear to me to be caries; this is a variety of osteitis which I designate by the name of atrophic rarefying osteitis. . . ."

The clinical picture of *spina ventosa* is too well known for me to dwell on it at length. M. Goetz distinguishes two stages: that of simple swelling, and that of ulceration. In the first stage, the finger, for example, increases in size, assumes a shape which has been compared to that of a flask, a radish, a spindle, etc. In the second stage, the skin, which was previously healthy, changes color, becomes tense, red, or purple; then, on the dorsal surface or on the sides of the finger, more rarely on the palmar surface, one or more points soften, give fluctuation, and ulcerate. Sanious pus flows out from the openings, which remain fistulous. When the probe is introduced into these openings, it comes down on the surface of denuded bone, if the abscess has been periosteal; or enters the enlarged medullary canal, if the abscess has started there, or in this and the inflamed periosteum at the same time. The base and edges of the openings are fungous and bleed easily, especially in the second case, which is the most common. Usually the joints are so free from trouble that the children continue to move their fingers. It is well known that portions of the phalanges, and even the whole diaphysis of a phalanx or of one of the metacarpal bones, may become necrosed. The probe will indicate the presence of these sequestra. I have already explained the mechanism of these forms of necrosis.

Spina ventosa without necrosis may recover spontaneously in the first stage. Little by little the sub-periosteal deposits of bone are absorbed,

¹ Volkmann, Ueber die Caries sicca des Schultergelenkes. (Berliner klin. Wochenschrift, 1867.)

everything retrocedes, and the bone resumes its normal shape. In the second stage, spontaneous recovery may still take place, after evacuation of the purulent collection and removal of the sequestra. The presence of the latter retard recovery until their elimination. In some cases—and these cases would be more numerous but for the surgeon's intervention—the disease goes on steadily from bad to worse: the swelling increases, the openings multiply, the joints are affected, the tendons of the extensors are attacked with inflammation and become filled with fungous masses, while the flexors, which are usually not much affected, contract and determine vicious positions of the parts. In some rare cases surgical treatment is powerless to stop this process, and it is necessary to have recourse to amputation of the finger.

M. Lannelongue has called attention to the eruption of tuberculous gummata, which is sometimes seen on limbs the extremities of which are affected with spina ventosa. The patients may have tuberculous osteitis at other points of the skeleton, and other strumo-tuberculous affections. I shall return to this soon, when speaking of the general condition. But, I wish beforehand to say a word about *perforating tuberculous osteitis of the vault of the cranium*. According to Volkmann, the symptoms are the following: A cold abscess marks its onset; the opening of this abscess lets out a characteristic cheesy pus, and discloses on the inner wall caseified tuberculous granulations. "Deeper down, the bone-tissue is found to be caseous and anæmic; often a sequestrum, as large as a pea, already occupies the substance of the bone; at other times, instead of a sequestrum, a perforation of the vault of the cranium is found; and then the pus which fills it pulsates. A fistula is established after the opening of the abscess, and this fistula may extend to the dura mater. Sometimes retention of pus gives rise to serious symptoms."¹

It is impossible to pass in review all the peculiar symptoms which may result from localization of tuberculous osteopathies in the different parts of the skeleton. The functional disturbances and the anatomical complications will be in relation with the functions and structure of the diseased parts of the skeleton, and of the organs which are near to them.

Thus far, we have considered only the local symptomatology. It is not less important to the diagnosis of the nature of osteitis, to fix our attention upon the *general condition and the antecedents of the patient*. In practice, it is by the general appearance of the patient that a diagnosis of the probable nature of his osteitis is made.

If one looks carefully at a number of patients affected with tuberculous osteitis or osteo-arthritis, two classes will be discovered. Those in one class are pale and bloated; their shape is full; their hairy development is sometimes very marked on the surface of the body, especially on the diseased limb; the cervico-maxillary region is surrounded with cicatrices of suppurating adenitis; the eyes show the marks of old attacks of keratitis and other ophthalmias. The others, on the contrary, are thin and dry, and bear no signs of adenitis or of ophthalmia. Some have the appearance of health; others show all the signs of profound cachexia. If the whole body of the patient be exposed, traces of former attacks of periostitis or osteitis are found, with cicatrices depressed and attached to the bones; of cold abscesses (if they have been large, these sometimes leave cutaneous markings like those of pregnancy); of subcutaneous gummata; of anal fistulæ; of epididymitis; of former operations, etc. This general inspection of the body should never be neglected; it is a fertile source of instruction as to the antecedents of the patient, as to his present general condition, as to complications, as to the

¹ Heydenreich, loc. cit.

multiplicity of the present osteitis, etc. The diagnosis of the nature of the disease is read on the skin of the patient when he is stripped.

Auscultation of the patient ought to follow this general scrutiny of the surface of the body. Too often there are found manifest signs of advanced pulmonary tuberculosis. In many cases there is found only blowing expiration, rough and prolonged; and sometimes also respiration is absolutely normal. I have under observation at the present time a patient who was castrated five years ago for tuberculous orchitis, and who manifests at this time osteitis of the sternum and of a number of other bones, as well as pseudo-rheumatic arthritis in several joints, but who has never had the least respiratory trouble.

In a majority of cases, questioning the patients will disclose the fact that some members of their families have died of a thoracic affection, and that they themselves have had, if they have not at this time, some lung-disease: hæmoptysis, bronchitis, or pleurisy. Heredity plays an important part in the etiology of tuberculous osteitis, which cannot be too much insisted on. But privations, poverty, bad hygienic conditions, excesses, all the causes of moral or physical debility, exercise no less influence. Heredity constitutes an innate predisposition; want of any kind, an acquired predisposition to the reception and evolution of the tuberculous contagium.

I purposely omit speaking here of scrofula, as I consider this diathetic entity an initial, mitigated stage—a period of outbreak of tuberculosis. The scrofulous and the tuberculous are candidates for pulmonary phthisis. The majority of patients affected with tuberculous osteopathies die phthisical, either before recovering from their bone-lesion, or sooner or later afterwards. A certain number of children die of meningitis, of enteritis, of tubercular peritonitis, or of acute phthisis. Outside of those cases, independent of bone-lesions, there are found commonly at autopsies numerous visceral ulcerations; tubercles, caseous masses, or cavities in the lungs; the liver is fatty; the kidneys are strewn with amyloid material. Amyloid degeneration of the kidneys seems to be less common in France than in Germany. We must not forget the tuberculous infiltration of the lymphatic vessels and glands—superficial or deep, near or remote—which are found in tuberculous osteopathies.

PROGNOSIS OF TUBERCULO-SCROFULOUS OSTEOPATHIES.—Tuberculous affections of the bones, being a manifestation of the tuberculous diathesis or infection, have necessarily a grave general prognosis. The patient who has an osteitis of this kind is threatened with the appearance of tuberculosis at some other point in his organism, and with death from phthisis. Nevertheless, if this is the rule, there are happy exceptions, the number of which depends on the conditions in which the patients live, or may be placed, in relation to hygiene, feeding, and care. The bone-lesion is susceptible of recovery, and it may even remain the sole and only manifestation of the contagion. The relative prognosis of the different varieties of tuberculous osteopathies is not the same; the encysted form, which has more tendency to spontaneous recovery, is more innocent than infiltration. The latter is perhaps less serious than caries, in the sense that it usually involves only the bone, at least originally, whilst caries generally implies a lesion of a joint and of the elements which compose it. The seat of the osteopathy modifies the prognosis. Thus, osteitis of the vertebre or of the pelvis, is more serious, because of the difficulty of surgical interference. Tuberculous osteopathy of the smaller long bones—*spina ventosa*—is usually not very serious: on the one hand, it recovers spontaneously; on the other, intervention is easy. Nevertheless, in very young children *spina ventosa* may be serious. The question of age is of

great prognostic importance. At the two extremes of life, tuberculous osteopathies are of greater gravity.

Finally, whatever may be the variety of tuberculous osteopathy, the prognosis is influenced by the general condition of the patient, his degree of heredity, and by the number of internal or external tuberculous affections which he exhibits. M. Ollier,¹ after having established the fact that pathological anatomy has not yet been able to furnish us with an infallible means of prognostication, adds: "It is upon other considerations that a prognosis must be based; upon the course of the disease and on the nature of the soil in which it develops. There is a serious tuberculosis and a benign tuberculosis. There is a generalized tuberculosis and a localized tuberculosis. There is a tuberculosis which inevitably progresses, there is another which tends to stop of itself. The one develops itself like an infectious and fatal disease; the other produces serious local destruction, but has not, at a certain state of its evolution at least, this invading course, and remains for a long time limited to the point originally affected. Experimental analysis may some day show us what clinical analysis has already led us to suspect, that is to say, affections of different nature among those which we now group together under the name of tuberculosis. It is probable that we confound under this name different pyogenic affections."

M. Ollier admits the contagiousness of tuberculosis, which has been so clearly demonstrated by the experiments of Villemin and of Chauveau, and which are likely to find a still more precise explanation in the investigations of Toussaint and of Koch. "But," he says, "there are already so many doubtful microbes, that it would be imprudent to accept a solution which is still only probable."

While awaiting the discovery of a demonstrable and really characteristic microbe in the blood of tuberculous persons, and until the method of experimental inoculations shall be made practically applicable, there remain for the surgeon, in order to estimate the degree of gravity of the different cases which are presented to him, only "study of the patient, study of the soil, consideration of the course of the affection based upon the reactional phenomena, and minute study of the internal organs (lungs, kidneys, intestines) which clinical observation teaches us are the usual theatre of tuberculous manifestations."²

TREATMENT OF TUBERCULO-SCROFULOUS OSTEOPATHIES.—The treatment ought to be directed not only by the local condition, but also and especially by the general condition, since the affection of the bones is only a manifestation of the constitutional vice, hereditary or acquired, which has engendered it.

I. GENERAL TREATMENT.—The treatment should therefore be above all medical. I shall consider this first, in order to show the importance which should be attached to it. All the means of hygiene, and of reconstructive therapeutics, ought to be employed: *Circumfusa et ingesta*.

Let us consider the former first. The question of the medium, of the habitat, leads all others. Most young subjects affected with scrofulo-tuberculous osteopathies have lived in badly ventilated, damp, cold, and dirty dwellings, in unhealthy quarters of large cities, or in the defective lodgings of poor peasants. It is also a matter of observation that, all other things being equal, cold and wet climates furnish a more considerable contingent to diseases of the bones than warm and dry climates do.

¹ Sur les résections et les amputations chez les tuberculeux.

² Ibid.

From these facts results the first and capital indication, to send the patient to a milder and more sunny climate, if possible; and, in any case, to place him in an airy, warm, and wholesome dwelling. The sea-shore, in a warm climate, or during the warm season, is of great utility, from the vital excitation which it produces by means of the saline emanations, and by the motion and purity of the sea-air.

Sea-baths, generally so justly recommended for their stimulating action, ought not, however, to be prescribed without caution; for impressionable patients, and those who have confirmed pulmonary tuberculous lesions, receive from sea-baths and from the air of the sea a sort of impetus which hastens the course of the phthisis. The sea should not be recommended to persons with pronounced pulmonary tuberculosis. Life in the country, in a warm region free from winds and from fog, will be more useful to them.

With the exceptions just mentioned, the sea-shore and short sea-baths are of great service in the affections of the bones which we are studying. No one can question the advantages which have been derived, for example, from the establishments of Berk-sur-mer, in France; of Margate, in England, etc., for children affected with tuberculous surgical affections. If there is a humanitarian wish to be expressed, it is that the hospital administrations of large cities should erect at the sea-shore homes for this interesting class of patients, and that in future they should build hospitals for children outside of the cities, in extensive grounds, well planted, and protected against cold winds, realizing all the conditions required by hygiene and needed for comfort. When it is impossible to ask from the sea its vivifying influence, sea-baths may be replaced by artificial salt-baths, and better still, by natural saline mineral waters, like those of Saline and Uriage. Good results may be secured from the effects of mixed baths, composed of sea-salt and of sulphate of potassium. When the use of baths is contraindicated by the weather, or for various reasons, general frictions of the body with different stimulating liquids may be employed. Baths, frictions, fresh air, sunlight, saline emanations, have for their object to whip up, as it were, the whole economy, by excitation of the skin and of the respiratory mucous membrane, so as to quicken the functional activity of the languishing organs, and thus to substitute an active and productive life for a languid and sterile one.

But if, in order to obtain greater speed in a locomotive, it is necessary to burn more fuel, it is also necessary to have richer food for an organism the renovation of which is desired. Feeding sometimes brings about astonishing metamorphoses, even in hospitals. Poor wretches, who have previously had only insufficient and unwholesome nourishment, finding there wholesome and abundant food, with a good warm bed, become transformed in a little while, gaining flesh and color. It is well to supplement food with a generous supply of good wine.

Cod-liver oil, iodine, the protiodide of iron, arsenicals, the different preparations of phosphate of lime, etc., are the tonic medicines to which recourse must be had, after improvement of the diet and amelioration of the hygienic surroundings. But, I repeat, fresh air, sunshine, good food, and sea-baths generally do more for children affected with scrofulo-tuberculous osteopathies than all the remedies which can be lavished upon them in a hospital. Bonnet's splints and invalid-carriages make it possible to extend the advantages of air and sunlight to patients whose bone-disease prevents them from walking.

As to internal remedies (creasote, phenic acid, salicylic acid, sulphate of quinine, bromine-water, oxygenated water, etc.) which have for their object the extinction of the tuberculous virus in all the tissues, its sterilization or

destruction, practice and experimentation have demonstrated their uselessness up to the present time. I will only speak of experimentation. MM. Parrot and Martin¹ have subjected tuberculous matter to the action of the various known parasitocides. They have reached the conclusion that the vitality of the microbe, comparable to reviviscent animals, is considerable, greater than that of the microbe of charbon; and that in therapeutic doses the known antiseptic agents, mentioned above, are incapable of destroying it. Heating to 100° C. (212° F.), and above, alone sterilizes the tuberculous virus. "The sole agent which germs cannot resist for an instant, whatever they may be, is fire."² This remedy is obviously inapplicable to internal lesions. With the object of preserving from contagion persons who live with tuberculous patients, MM. Parrot and Martin propose to subject, from time to time, the furniture and the flooring* to a current of air heated to about 125° C. (257° F.), by means of tubes to conduct it as irrigating tubes conduct water. It is to be feared that over-logical minds might propose from time to time to burn the house. In this case barrack-hospitals would become the ideal. We must acknowledge that therapeutics and prophylaxis are as yet of no use, and that only hygiene and good feeding enable us to contend, often indeed with advantage, against the tuberculous virus.

II. LOCAL TREATMENT.—General treatment, the outlines of which I have just traced, aids powerfully in the cure of tuberculous osteopathies, and by itself sometimes secures it, but not always; and it is usually necessary that local treatment, direct treatment of the external lesion, should lend its assistance.

Before speaking of local treatment, I ought to say what is the natural course of external tubercles, either in an otherwise healthy subject, or in one with pulmonary tuberculosis: (1) They may, as Charles Nélaton says, "*recover* by surrounding themselves with a fibrous new formation or by themselves undergoing a true sclerosis, gradually eliminating the degenerated and caseified products; (2) they may remain *stationary*, at whatever stage they may be; (3) they may pursue an *extending* and locally invading course. But, in all these three cases, the disease, which at first was local, may become generalized. When surgical lesions develop in a patient who already has tubercles in his lungs, the same terminations may be seen, although here the spontaneous course toward recovery is less frequent."³ External tuberculosis may end in spontaneous recovery, whether present alone or accompanied by similar lesions in the viscera. If spontaneous recovery takes place by absorption of the tuberculous masses and by sclerosis of the connective tissue which takes their place, or by elimination of degenerated and caseified products, the surgeon ought to endeavor: 1st, to favor absorption and sclerosis of the tuberculous masses by substitutive irritation; and if he cannot obtain this, 2d, to hasten the elimination of the degenerated products by removing them, or to destroy them where they are found, at the same time provoking a frank inflammation of the surrounding tissues which are still healthy, or which have undergone retrogressive modifications to only a slight degree.

(1) *Means designed to favor absorption of the products of tuberculous osteopathies.*—Encysted tubercle is the only form in which recovery can occur without elimination. The absorption of abscesses by congestion, of vertebral or other origin, cannot be denied. The majority of surgeons have observed the disappearance of ossifluent abscesses without operative interference, espe-

¹ Recherches expérimentales ayant pour but de transformer le tubercule vrai ou infectueux en corps étranger inerte; 2e mémoire (Revue de Médecine, Oct. 1883).

² Ibid., p. 823.

³ Op. cit., p. 140.

cially in children and adolescents. When the patient refuses to be operated upon, or when there is any hope of securing absorption of the encysted tuberculous products, recourse may be had to the measures which I am about to describe. I have just mentioned the importance of general treatment. Great attention must be paid to this. It is in cases of this sort that sea-air and sea-baths are especially indicated, provided that the lesions are not very extensive and not painful, that the abscess is not large, that the lungs are almost intact, and that the tuberculosis is sluggish in its manifestations. Cod-liver oil ought to be insisted upon, and the phosphates, and the iodide of potassium in large doses. The excretory functions ought to be stimulated by repeated administration of purgatives and diaphoretics. Of late, jaborandi and pilocarpine have been much praised. But, for my own part, I have never seen an ossifluent abscess disappear in consequence of diaphoresis or salivation provoked by these substances. At any rate these tentative modes of treatment should be avoided if the patient is cachectic or has fever.

The local measures, capable of bringing about absorption of a tuberculous bone-manifestation and its products, are resolvent applications of the tincture of iodine, of mercurial ointment, of blisters, etc., with compression preceding, following, or accompanying the resolvent applications. Compression with wadding impregnated with extract of jaborandi, and an elastic bandage, when it can be employed, sometimes procures good results. It has been recommended also to employ actual or potential revulsion. Thus the actual cauterium has been seen to conjure away an osteitis at its beginning. Combined with compression by wadding, and with immobilization, actual revulsion is to be recommended in the highest manner. How many patients owe it to this that they have not been subjected to gouging or resection. Immobilization alone may sometimes suffice to prevent the formation of an abscess or to lead to its absorption, if it is present. In case of tuberculous osteopathies of the vertebræ, I cannot recommend too strongly the plaster jacket, which immobilizes the vertebral column better than any other apparatus, while it enables the patient to enjoy life in the fresh air and in the sun, and to use his limbs. Bonnet's splint ought not to be recommended except when the abscess has opened at some point on the trunk, or when there is ulceration at the point of curvature. The plaster jacket put on in the beginning, usually prevents the formation of abscesses, and favors the spontaneous recovery of vertebral osteitis. If immobilization is indispensable in Pott's disease, it is no less necessary in tuberculous osteopathies of the parts near the joints, and of the joints themselves, as every movement increases the inflammation and pain. It is less indicated in osteitis of the diaphyses. Nevertheless, we have all seen that walking and fatigue aggravate these lesions, and that rest always brings a diminution of the pain and inflammation. Being limited and sluggish, bone-tuberculosis sometimes permits the patient to earn his living in one way or another, upon condition of giving up work from time to time. I know a man about thirty years of age, who, since he was sixteen years old, has dragged about in this way a tuberculous juxta-epiphyseal and diaphyseal osteopathy of the tibia. He stops work when the seat of disease, which has been gouged out several times already, and the fistulous tracks, inflame; then, after a few days of rest, he gets better and resumes his ordinary life.

(2) *Measures intended to hasten the elimination of the products of Scrofulo-tuberculous Osteopathies, or to suppress more or less radically the local lesion.*—I have referred to ossifluent abscesses. To follow the natural order of events, I will begin the description of the operative treatment with them. Abscess precedes fistula, and the fistula leads to the seat of osteitis. I shall therefore

occupy myself first with the ossifluent abscesses, then with the fistulous tracks, and lastly with the bone-lesions.

Ossifluent Abscesses.—Small, accessible abscesses should be opened when all hope of resolution has been lost. The course to be pursued in regard to large sessile abscesses, or abscesses by congestion, has varied very much. Formerly these abscesses, the latter especially, were considered a sort of *noli me tangere*. Antiseptic dressings and methods have completely revolutionized surgery in this matter, as in many others. Since Volkmann and Lannelongue have shown that the walls of these abscesses are filled with tuberculous matter, and since antiseptic methods dispel the danger of pyæmia and septicæmia, these abscesses, which were formerly so much feared, have been attacked boldly. Sessile and accessible abscesses may be simply opened with a bistoury, a drainage-tube being placed in the incision, which is then dressed antiseptically, in the manner of Lister. Complete evacuation of the abscess and washing out its cavity with carbolized water, is not, I think, indispensable. Simple incision and drainage have given me good results. Only cicatrization takes a longer time, and the dressing demands much care that no agent of fermentation shall enter the suppurating cavity. When the abscess is easy to reach and not in a dangerous region, when the sac is not deeply buried in the thickness of the limbs, or is not situated in cavities such as the abdomen or the thorax, recourse may be had to a more radical treatment, to scraping out or extirpation of the pocket which contains the collection.

(a) *Scraping.*—A sufficiently large incision having been made, all the tissue in the pocket which looks and feels like mucous membrane is to be removed by the aid of a sharp curette, until the wall of the cavity has been transformed into a bleeding surface. If the diseased point of bone be discovered—and it should be sought for—it will be proper to profit by the laying bare of the abscess to treat it, according to the case, by scraping, if the lesion is superficial; by rasping, by gouging, by resection, etc., if it is deep, as will be explained hereafter. But let me speak only of the abscess itself. After having washed the bleeding surfaces with carbolized water, or with corrosive-sublimate, salicylic-acid, or some other such solution, some surgeons close the whole completely with sutures. I think, with M. Lannelongue, that it is more prudent to place a drainage-tube in the most dependent portion of the wound.

(b) *Extirpation of the Sac.*—M. Lannelongue has proposed decortication of the sac. When the abscess is not too extensive, nor too full of diverticula, it is easy enough to detach its envelope by means of a blunt instrument, closed scissors, a spatula, the finger, etc. Scraping or decortication, the result is the same; the sac is removed, and its removal leaves behind a bleeding surface, less in the second case than in the first. It may be asked, with M. Verneuil, if this breaking of the vessels which encircle the region does not set up a most powerful process of auto-inoculation. This danger is perhaps not as great as might be feared; for, on the one hand, the flow of blood prevents the penetration of the tuberculous juices, and, on the other hand, the washings which are made during the scraping carry off, to a certain extent, the *débris* of the sac. *A fortiori* is this true of decortication. M. Ollier has proposed scraping with the aid of Esmarch's hæmostatic apparatus, when the region admits of it, in order to avoid the danger pointed out by M. Verneuil. It will be well, to insure the aseptic condition of the wound and to destroy the tuberculous germs which may remain there after the final washing, to powder the surface with iodoform. Internal ossifluent abscesses of the bones of cavities, such as the pelvis, the cranium, etc., require trephining; absolutely for the cranium, less invariably for the pelvis, as this cavity offers numerous

ways of escape for the pus. I have seen, in the service of M. Ollier, trephining of the iliac bone, of the sacrum, of the vertebræ, give brilliant results in such cases.¹ It is certain that if the abscess of the pelvis is dependent upon a coxalgia, and if resection is indicated for this, one should never fail, during the operation, to perforate the cotyloid cavity, if it is not perforated already, to give exit to the pus in the pelvis. Drainage of the cotyloid cavity is very efficacious with the last method of resection of the hip devised by M. Ollier. I have practised a resection of the hip in these conditions, and thus far with a perfect result, and one which is the more fortunate since the patient is a young man, 24 years old, who has also a huge abscess by congestion, of vertebral origin, which has opened spontaneously above Poupart's ligament on the other side.

As for *abscesses by congestion*, if they are accessible in their whole extent, they should be treated like sessile abscesses. An abscess by congestion, of vertebral origin, cannot be subjected, it will be understood, to scraping or to decortication. There can be no question of surgical interference unless it has become accessible, either in the dorsal, lumbar, or gluteal region, or at the root of the thigh. Only simple opening, with drainage, can be applied to these abscesses. M. Lannelongue advises that all the pus should be evacuated after incision, and that a drainage-tube should be introduced as far as possible, by means of which injections of carbolized water can be made until the pocket is perfectly cleansed. On the succeeding days the same washings are repeated when the wound is dressed. The fever which follows this operation soon subsides. For my own part, I have opened a large number of abscesses by congestion without washing out the sac, and I have never seen fever follow. This, moreover, is the way which I saw employed by Lister. The washing and pressing out of abscesses cause lacerations of the vessels, which create as many mouths for the occurrence of absorption.

When the abscesses have voided their contents, and persist in the condition of *fistulous tracks*, giving vent to thick serum or badly formed pus in variable and intermittent quantity, what ought to be done? From the effect, we must advance to the cause; from the abscess, to the bone-lesion which keeps up the suppuration. The measures which have been proposed and employed are the following, in the order of their importance: (a) Modifying injections. (b) The actual or potential cautery. (c) Gouging. (d) Resection, or complete ablation of the bone. (e) Sometimes, amputation of the limb.

(a) *Modifying Injections*.—These have been employed from all time, and have enjoyed the more favor as the results of operations were more doubtful. Their object is to excite a healthy reaction in tissues the vitality of which is feeble, and to favor the elimination of degenerated parts. If the tracks are sufficiently straight, the injection has a chance of reaching the diseased bone; but if they are very sinuous, the penetration of modifying liquids will be of no real utility unless preliminary drainage has been made, as Chassaignac and M. Ollier have advised.

The liquids employed, or proposed, for these injections have been very numerous. I shall mention only those which have remained in use. The tincture of iodine, as efficacious as it is harmless, and Villate's solution, which was introduced to human medicine by Notta, of Lisieux, ought to be mentioned as in the first rank. Charles Heine attributes the cases of death noted after the employment of Villate's solution to the excess of acetic acid which it contains. For this reason he has modified the formula in the following way: Sulphate of copper and sulphate of zinc, of each five

¹ Gouilloud, *Ostéite du bassin*. (Thèse.) Lyon, 1883.

drachms; distilled water, five ounces. M. Ollier rarely uses the pure Villate's solution. He dilutes it with from two to four parts of water. One may also employ more or less concentrated solutions of nitrate of silver, of chloride of zinc, of compound tincture of benzoin, of liquid balsam of opodeldoch, of tincture of aloes, of balsam of Peru, of an ethereal solution of iodoform, of oil of eucalyptus—or simply of olive oil, as employed by Vallette, of Lyons—and of alcoholic solutions of creasote. This last substance has been experimented with in clinical surgery, with the double purpose of exciting the tissues and of destroying the tuberculous germs in them, according to the ideas of MM. Gimbert and Pidoux. The results have not shown anything remarkable. Moreover, it has been employed only after resections, in open cavities, to modify the nature of the fungous growths coming from the synovial membrane—from the soft parts, as well as from the ends of the bones. In such cases irritating injections may produce all their effect, and they are generally of great use. The same is not true in regard to unopened cavities. The injection here produces a decided effect on the sinuses only, but it does not reach—or it does so only superficially and incompletely—the diseased bone, and therefore does not modify the course of the disease. As antiseptic dressings render operations of exæresis almost free from danger, we should not lose time in using these irritating injections, even varying them. Early operation is an economy of time and of suffering for the patient, who, relieved of his bone-lesion, will be less enfeebled, and will repair his physiological losses the sooner.

In fact, irritating injections should be reserved for the after-treatment of operations, if fungous growths appear and retard cicatrization. Apart from this, I do not believe that irritating injections should be systematically employed in preference to the measures which I am about to mention, unless in case of a very limited and very accessible lesion, or in case of extreme cowardice or feebleness of the patient. And even in these cases I should prefer simple antiseptic washings which would have the advantage over irritating injections of not causing the patient useless suffering.

(b) *Cauterization of the Diseased Portions of Bone.*—Cauterization, says M. Ollier, “brings about necrosis of the carious portions; it imitates the process by which nature puts an end to caries in many cases. It has the advantage over spontaneous mortification of the diseased bone of exciting an energetic irritation, a healthy inflammation in the tissues which surround the necrosed part.”

The *red-hot iron* and *caustics* are the means by which cauterization is practised. The thermo-cautery of Paquelin may be used for mild cases, and the old, larger cauterizing irons, brought to a red heat, for cases requiring energetic action. The galvano-cautery is not adapted for real service in these cases. Among caustics, I will recall the numerous corroding tablets of the ancients, and will only mention, among modern caustics, nitrate of silver, chloride of zinc, in the form of Canquoin's paste, the caustic of Filhos, sulphuric acid, etc.

Usually cauterization, whether actual or potential, does not provoke mortification of thick layers of bone, unless this is softened, and approaches, by its degree of medullization, the consistence of the soft tissues. On the other hand—and on this account I never employ them—energetic caustics may cause great and very dangerous disorders in the soft parts.

The experiments of MM. Pasteur and Chauveau upon the attenuation of viruses by heat, give very great importance to the radiation from the red-hot iron; and for this reason the old cauteries should be preferred to the thermocautery, as the latter gives but little radiating heat.

Starting with this fact, I conceived the idea of proposing and practising

breaming the bones and joints with extremely large cauteries. M. Laroyenne has made the very just observation that the bones are heated more rapidly and more extensively when they are rendered bloodless with the Esmarch bandage, than when they contain their normal quantity of blood. If we desire to profit by the advantages of heat as a means of sterilizing or destroying the tuberculous virus, we must practise igneous cauterization of the diseased parts of the bone, with the precaution of elastic hæmostasis if the region permits. Actual cauterization deserves to be preferred, because the heat acts at a distance directly upon the microbes, and because it is easy of execution.

In what manner and to what extent ought it to be used: 1, in osteopathies of the diaphysis; 2, in juxta-articular osteopathies; 3, in articular osteopathies?

If the osteopathy is in the diaphysis, it is necessary, after having exposed the diseased surface, to touch it fearlessly and vigorously with the red-hot iron, applying the cautery firmly. Usually the depth of the diseased part and the presence of a sequestrum require a previous operation of sequestrotomy, scooping, or gouging, and then cauterization will be only the complement of an operation more radical than itself, and one which surpasses it in importance.

If the osteopathy is *juxta-articular*—if it is situated in the dia-epiphyseal bulbous enlargement, and consequently in the spongy tissue—cauterization will have more effect, and therefore ought to be employed with some caution. It is advised not to practise it too energetically, for fear of provoking inflammation of the neighboring joint or of the medullary canal. But as, on the one hand, the joint and the medullary canal are in many cases invaded, the one by fungous growths, the other by ossification of the medulla, and as, on the other hand, antiseptic dressings and immobilization enable us to prevent pyæmic infection, it is possible, nowadays especially, to use the red-hot iron without fear, even near the joints and the medullary canal.

Finally, if the osteopathy is *in the epiphysis*, or *articular*, cauterization loses almost all its advantages, at least for large joints in the adult. For here it is altogether insufficient. If the joint is affected as a whole, in its osseous and connective tissues, it is impossible for cauterization to reach all the centres of disease. These cases enter the domain of resection or of amputation. Gouging is no more sufficient than cauterization.

Intra-articular cauterization seems to me to be suited to large joints only when there is a simple tuberculous synovitis, or very slight lesions of the ends of the bones. I have designed an operation to which I have given the name of "*igneous arthrotomy combined with articular breaming and immobilization.*"¹ I open the joint with a red-hot iron, with a cutting thermo-cautery, or even with a bistoury, through the fungous masses; then I scorch with the red-hot iron the bleeding surfaces of the incisions, usually two in number, one on each side of the joint. When the joint is opened I bream it with enormous cauterizing irons until the fluids which escape from it are at a temperature which the finger cannot bear. The fungous growths having been cauterized and the joint having been breamed, I saturate the surfaces with iodoform, and, applying a strict Lister dressing, I immobilize the limb with a silicate bandage. The results obtained by this procedure up to the present time are very encouraging. But there can be no question of it if the articular extremities of the bone are seriously diseased. Then resection is demanded,

¹ De l'arthrotomie ignée et du chauffage articulaire, combinés avec le pansement antiseptique iodoformé et l'immobilisation dans les synovites et ostéo-synovites fongueuses (Revue de Chirurgie, 1884).

especially in the adult. I except only the joints of the carpus and tarsus, including the wrist and the ankle, in young patients, whose bones, not hard in the healthy state, soften so fast, when they become inflamed, as to be easily divisible with the knife. Then the joints and the bones may be *tunnelled* with the red-hot iron, according to the expression and practice of M. Ollier. Cauterization ought to be tried before proceeding to a more radical operation, especially in the foot. In the hand, the great advantage of obtaining a movable limb by resection, ought to lead to choosing this operation more readily if the first cauterizations with nitrate of silver or with the hot iron do not bring about a prompt and sensible amelioration.

(c) *Scraping the Bone, Trephining, Gouging*.—These operations attack the bone directly in order to remove from it the diseased parts. The indications are almost the same as for cauterization, according to the part of the bone affected. Scraping out a joint (*arthrodesis*) does not deserve the credit which has been attached to it of late, no matter in what way it is performed. In fact, if it is practised by passing the sharp curette through the fistulous tracks, or through incisions which do not expose the whole of the joint, it is insufficient. We are not sure of removing the whole of the diseased tissue, and we act in the dark, in a case in which intervention is not justifiable unless it attains its object with certainty.

If the joint is freely opened, we can, it is true, form a better idea of the bone-lesions, and we can no doubt practise excision with more ease and sureness; but even here intervention will miss its object, as far as the bone is concerned; for it is not enough to remove the fungous growths with the curette, and to scrape the diseased bone-surfaces, but it is necessary to remove them completely; if this be not done, osseous layers will be left behind, the enlarged alveoli of which are full of tuberculous matter. When applied to the synovial membrane and to the soft parts, scraping may, on the other hand, have the disadvantage of removing too much, and of cutting off parts which would be of use in the reconstitution of the joint. This is also M. Ollier's opinion. On the other hand, abrasion can only leave an anfractuous cavity which is ill adapted to complete drainage, and consequently exposes the patient to retention of septic liquids. For these different reasons, scraping and gouging of the joints do not seem to me to be acceptable operations, and I generally prefer resection, which is more sure to get rid of the tuberculous patches, and is less dangerous, because it leaves a cavity which is free from diverticula, and from which fluids can be entirely removed by drainage.

In cases of tuberculous juxta-epiphyseal or diaphyseal osteopathy, gouging is an operation the excellence of which no one can question. It has been practised from all antiquity. Nowadays, with the bloodless method of Esmarch, it has become a procedure of extreme ease and certainty. As blood does not flow into the wound, it is easy to follow up the fungous growths and sequestra, into all the diverticula of the osseous cavities, and to cut off the diseased parts from the walls of the latter.

Antiseptic dressings render this operation absolutely harmless. When the seat of the osteopathy has been diagnosticated, the soft tissues are to be incised down to the periosteum, and the whole is to be detached with an elevator. If there is a shell of new-formed bone-tissue surrounding a sequestrum, this shell should be opened by means of a trephine or a chisel and mallet; then the sequestrum should be extracted and the fungous growths of the cavity removed with a curette, and finally its diseased walls must be gouged off. If necessary, when the cavity is deep and the region is suitable, the floor of the excavation is perforated with a trephine for the introduction of a drainage-tube, that thus we may prevent the pus from stagnating as if in a basin.

Ought cauterization to be always combined with gouging? It appears to

me that we may here distinguish two sorts of cases. Either the sequestrum is compact, hard, and isolated, in a cavity the walls of which are sclerosed and eburnated—all these circumstances indicating an effort of nature, which is very near conclusion, toward a cure—or the sequestrum is vascular, spongy, and united by fungous growths to walls which are not sclerosed, but rarefied, and which are themselves affected by the same process which has given rise to the sequestrum. In the first case cauterization is useless; the process is going on to spontaneous recovery; as soon as the sequestrum is removed, granulations of a healthy type will appear, and will more or less fill the cavity. The peripheral hyperostosis will diminish by absorption, by hardening of the connective tissue of the large canals of Havers, and by condensation of the bone-tissue. In the second case the process is not yet circumscribed, it is extending, it invades without intermission the bone-substance which surrounds the original seat of disease. Here cauterization ought to follow the extraction of the sequestrum; but it is necessary to scoop out the cavity beforehand, removing with the sharp curette, or with the gouge, the infiltrated bony walls, until healthy tissue is reached. The bloodless method of Esmarch, while it facilitates this operation, sometimes makes it hard to distinguish healthy tissue from tissue which is beginning to be diseased. M. Ollier gives it as a practical rule, to limit ablation to the parts which are clearly altered. "It is best to stop as soon as there is no more pus infiltrated in the areolæ of the medulla; it is best to leave not only that which is perfectly healthy, but also that which is capable of becoming so; parts which are simply rarefied will reorganize under the influence of the healthy irritation which follows the operation."¹

In such a case, cauterization with the red-hot iron would be a useful adjunct to gouging, as an irritant and as a parasiticide. Iodoform also will render marked service. There may be placed in the cavity of the bone an iodoform-gauze tent, such as is used by Mosetig, or a bag of carbolized gauze filled with a variable quantity of iodoform. One may also be content with powdering the walls and the bottom of the cavity with pulverized iodoform. I have never seen an accident caused by this substance. In case the tuberculous osteopathy is superficial and has not given rise to the formation of a sequestrum cavity, scraping with the gouge, with the elevator, or with the sharp spoon, will usually suffice. According to the importance of the cases, these measures may be associated with cauterization. I have said, in speaking of ossifluent abscesses, that it is sometimes possible, in one and the same sitting, to scrape out the superficial tuberculous osteopathy, and to extirpate, or destroy by tearing off, the sac which had collected the products of tuberculous solution and of eliminative suppuration.

(d) *Resection or complete ablation of the diseased bone; (c) Amputation of the limb.*—When the tuberculous osteopathy is in the diaphysis, gouging will suffice in the majority of cases, and there can only very exceptionally be a question of lateral resection, or of total resection of a segment of the bony cylinder. Of course the periosteum should be preserved, in order to secure reproduction of part of the removed bone, by the periosteum or by ossifiable medulla, derived either from the canals of Havers or from the medullary canal of the cut surfaces of the bone.

When the osteopathy is in the epiphysis, the problem of exeresis will receive a different solution in different cases. When the joint is not involved, when the osteitis, although in the epiphysis, is still covered by the articular cartilage, we may now, with the dressings of Lister, subject these centres of osteopathy to gouging. The most ordinary prudence will indicate, in such

¹ Carie (loc. cit.).

a case, to immobilize the limb in a splint, or better still in a plaster dressing. I can count a number of successes obtained in this manner and under these conditions. It is possible in some cases, even in the knee, to have success after gouging through the articular cartilage and opening the joint. But for this it is necessary that the diseased part should be quite limited, and that its presence should not have provoked grave inflammatory impairment of the neighboring articulation. Such cases are rare. It is almost always necessary to have recourse to a complete resection of the joint. But when the primary or secondary osteopathy is continuous with an arthritis—when, in fact, there is present an ordinary white swelling, a fungous panarthritis—there can be no thought of anything but resection or amputation.

As resection preserves the functions of the limb, when it is done properly, according to the principles of the sub-periosteal method, it ought to be preferred to other conservative operations for joints the mobility of which is their predominating advantage, and *a fortiori* to amputation. "For white swellings of the elbow and shoulder," says M. Ollier, "it is better to resect as soon as the joint contains pus, even before the opening of the abscess." Such is the rule for the upper limb. In the lower limb, on the contrary, solidity of the joint, ankylosis, being more advantageous than mobility, there is less urgency for having recourse to resection. One should not resolve upon this operation until after having exhausted all the measures capable of procuring recovery with ankylosis: revulsion, superficial and penetrating cauterization with the hot iron, arthrotomy with the hot knife, breaching of the joint, and always immobilization. And, finally, when resection is practised in the lower limb, the surgeon should always aim to favor, either by the method of operating or by the after-treatment, the formation of solid ankylosis—*bony*, when it is possible—if not by osseous union of the resected bones, end to end, at least by the formation of peripheral periosteal bony layers, inclosing the bones in the manner of a ring.

Expectation secures, in the well-to-do classes, excellent results, even in cases of suppurative inflammations of the hip and knee. In Germany and in England, after having practised resections of the hip and of the knee to excess, there is a return to those principles of conservatism from which we have never departed in France, at Lyons less than elsewhere, where the memory of Bonnet is kept alive. Therefore, in the lower limb, the rule is never to resect until after all the resources of conservatism and bloodless treatment have been exhausted.

Independently of these physiological considerations, the choice between resection and other methods of intervention ought to be suggested by the general condition of the patient and his social position. Amputation, of which I have not spoken yet, is an extreme measure, to which we resort less and less, in proportion as we get the habit of resecting early (in the upper limb), and as by practising resection in a correct manner we are better able to derive from it the benefits which it is capable of procuring.

In my opinion, it is not fair to compare tuberculosis with cancer; because quite often a cutaneous, osseous, or pulmonary tuberculosis is recovered from, whilst recovery never, or almost never, follows cancer. To extol amputations and to practise them hastily, acting upon an erroneous analogy, is a surgical error deserving condemnation. The results of resections in the hands of my excellent teacher, Professor Ollier, have thoroughly convinced me that less is generally expected from this operation than it is able to give, and that it is going astray to attribute to the discovery of the tuberculous follicle and bacilli an exaggerated practical significance. There are degrees to the virus and to its malignity. Besides, in order to lead to the acceptance of so radical a kind of surgery, it should be possible to demonstrate

that in amputating, or in extirpating everything which appears diseased in resecting a joint (the synovial membrane, the ligaments, etc.), the whole of the disease is really extirpated. M. Ollier, from facts observed in his clinique, insists upon tuberculous infiltration of the lymphatic glands situated above the diseased part, and very deep. You may indeed have amputated the thigh for a white swelling, but you cannot say that you have done a radical operation, as far as the tubercle is concerned; for you leave behind the femoral ganglia, which cannot all be removed, and also the pelvic glands, which are tuberculous. Resections and amputations will always leave behind the thoracic or pelvic ganglia, even though it be recognized as the rule to complete these operations by enucleation of all the swollen glands of the limb. If this be so, it ought to be made a rule to prefer resection to amputation, and not to decide upon the latter, except as a last resort.

If the general condition is very bad, if the local disturbances are very extensive, involving at the same time and seriously the bone and the soft parts, if there is very abundant suppuration which is causing the exhaustion of the patient, and if, at the same time, the latter is advanced in years and cachectic, amputation is a necessary sacrifice. All things being otherwise equal, considerations of fortune, of social position, of profession or of trade, will enter into the question as to the course to be pursued. In the lower limb, an amputation of the thigh or an amputation of the leg will often be more to the true interest of the patient, if he is destitute of means, than a resection of the knee or of the ankle.

Are resections or amputations justifiable in tuberculous subjects? This is the last and important question which we must ask ourselves at the end of this study. Ought tuberculous persons to be operated upon? Professor Verneuil and his pupil M. Leroux¹ have presented a gloomy picture of the results of operations on tuberculous patients. It is certain that cases may be cited in which an operation, however slight, has caused an outbreak of tubercle in the lungs or other viscera. But it is no less certain that to these can be opposed other cases in which there have occurred very perceptible amelioration and even disappearance of pulmonary lesions which existed before operating. M. Ollier has reported cases of this kind in his memoir on resections and amputations in tuberculous subjects.

On the other hand, there are quite a large number of patients who, having been subject to amputation or resection when their lungs were unaffected, have remained long years, and even to the end of their lives, without having the least tuberculous lesion in any part of their organism. In the third place, antiseptic dressings, by suppressing complications in wounds, by reducing suppuration to almost nothing, have freed the operative traumatism from the disastrous consequences which formerly followed it. The tuberculous person may die of pulmonary or visceral tuberculosis sooner or later after the operation—M. König has labored to demonstrate this, but we knew it only too well before—but an antiseptic operation will not shorten his days. On the contrary, an operation, by removing an external tuberculous centre, removes at the same time a cause of exhaustion (by suppuration, want of exercise, absorption-fever, suffering, anorexia, and insufficient assimilation), and a source of infection. Consequently, it places the patient in better condition to escape generalization of the tuberculosis, and to resist the present attack as well as future contagion. Therefore one can, and one should, operate upon tuberculous patients, whether their lungs are affected or not. I have seen, in the service of M. Ollier, patients who have had the signs of cavities, stationary it is true, much benefited by operation. The coincidence of tuberculosis of the

¹ Des amputations et des résections chez les phthisiques. (Thèse.) Paris, 1880.

lungs with a tuberculous osteopathy contraindicates operation only when it is malignant, when it is progressing rapidly to disorganization of the lung. Even in this case, if the pains of tuberculous osteitis or osteo-arthritis were excessive, one might, after the example of M. Ollier, operate merely for their relief. In the discussion upon this question which took place at the Société de Chirurgie, in 1878, M. Trélat laid down the following rule of conduct: It is right to operate as soon as a tuberculous lesion is recognized, whether the affection be independent of any alteration of the lungs, or developed in a phthisical patient; since, in the first case, the external lesion is cured, and the patient is enabled to build up his organism by being freed from a centre of infection; and because, in the second case: 1st, the external lesion is cured; 2d, he is given a chance to have his pulmonary lesion improve. M. Ollier, after having considered this question with the broadness of view which is habitual with him, in the memoir just cited, has formulated the following conclusions, which I shall reproduce in part:—

“1st. Resections of the joints practised upon tuberculous subjects may give durable results. They make it possible not only to secure a local cure, but also to put a stop to the general disorders which have their source in absorption of the products of tuberculous centres in the joints; . . . 4th. Resections of the joints, in patients who had manifested all the anatomical and clinical signs of a tubercular affection, have enabled me to obtain recoveries which have been maintained for fifteen years and more; . . . 6th. Theoretically, amputations are a better protection against secondary infection than resections; but they never constitute a radical operation. The deep and inaccessible lymphatic glands which are already invaded by tuberculosis remain behind in both cases. 7th. Resection, followed by complete local recovery, that is to say, by final cicatrization of the wound, leaves no greater risk of secondary tuberculous infection than amputation. 8th. Hygiene and general medication are of very great importance in modifying the soil in which tuberculosis may be developed. Local modifiers may destroy the tuberculous tissues and transform them into stable cicatricial tissue; this transformation, moreover, takes place spontaneously in many patients, especially in children.”

RACHITIS.

Rachitis has been already described among constitutional diseases by Dr. Lewis Smith,¹ and my task is thus much simplified; indeed, I should have had nothing to say if Dr. Smith had recognized the occurrence of rachitis after the earliest childhood. He confines himself to stating that Glisson, Portal, and Tripier, observed the appearance of rachitis near the time of puberty, and that Sir William Jenner has seen children seven or eight years old having a first attack of the disease. He himself knows of no case occurring after the first years of life, and the way in which he speaks of the observations of Glisson, Portal, Tripier, and Jenner, leaves us to suppose that only the authority of the observers prevents him from rejecting them. Nevertheless, the occurrence of this late form of rachitis cannot be denied.

RACHITIS OF ADOLESCENTS; LATE RACHITIS (OLLIER).—In my opinion, rachitis may appear at all stages of the growth of the skeleton, and its manifestations are in direct ratio to the activity of the physiological processes peculiar to the age of the patient. In other words, the younger the subject, the graver the rachitis; the greater the osteogenic activity, the greater will be its perturbations, the more marked the rachitis, all other things being equal. During the whole period of growth, the work of increase of the

¹ See Vol. I. page 255, *supra*.

skeleton may be disturbed, and rachitis appear, if the conditions which give rise to it are present.

Causes.—These conditions may be summed up in one word—physiological want, a want which may exist in the very bosom of abundance. Grave fevers, typhoid fever, measles, scarlatina, etc., often give rise to it. This is why we sometimes see rachitis appear during convalescence from these diseases. I have at least observed this of scoliosis. But besides these pathological states, there are, for both sexes, special causes which explain both late rachitis and the deformities to which it gives rise. In young girls, the preparation for, and the establishment of, the catamenial flow, often cause profound anæmia, depression of the strength, general languor, and well-marked disturbances of nutrition, the degree of which is proportioned to the activity of growth and to the social condition of the subject. If to these causes of physiological want, and of rachitis, we add the influence of a more sedentary life—one in which there is more sitting down—and the wrong attitudes which children assume in school, the frequency of scoliosis in little girls from nine to fourteen years old, will be easily understood. To me it appears that the scoliosis of adolescents is a late vertebral rachitis. Among young boys, the storms of puberty, with the debility which accompanies it, the rapid growth which coincides with this period of life, the lymphatic temperament, etc., also give rise to the same physiological want which disturbs the work of ossification and brings on rachitis. The less sedentary life of the young boy—the being more on his feet—his walking more than girls, predispose him more to the manifestations of late rachitis in the lower limbs, and especially to knock-knee, than to scoliosis. I shall hereafter give an example of late rachitis of the femur.

These evolutionary causes, which are common to all classes of society, and perhaps a certain predisposition, receive powerful assistance from the privations and sufferings of poverty and of bad hygienic surroundings. Poor and insufficient food, want of heat and ventilation in their dwellings, premature work, and work which exceeds the strength of young persons, explain why deviations in shape, and deformities of the limbs and pelvis, are more frequently met with in the poor and laboring classes. Mikulicz has made a curious observation. In Vienna it is especially young bakers who are affected with knock-knee. The journeyman baker is badly nourished, turns night into day, goes out but little, does not sleep enough, sweats a great deal in the exercise of his calling in the midst of an overheated atmosphere, etc. These are so many causes of debility and imperfect ossification, that is to say, of rachitis. This disease manifests itself in the baker's young apprentice preferably as knock-knee, because when he kneads the dough he puts his knees together and separates his feet, so as to have a larger base of support and to work the dough with greater strength.

Physiological want and vicious attitudes, such are the usual causes of rachitis and of the deformities by which it is accompanied in adolescents. If we should follow up the different callings and the different conditions of existence of rachitic youths, we should find the predisposing cause of the rickets as well as the mechanical reason for the bony deformities, among which scoliosis and knock-knee are the most common.

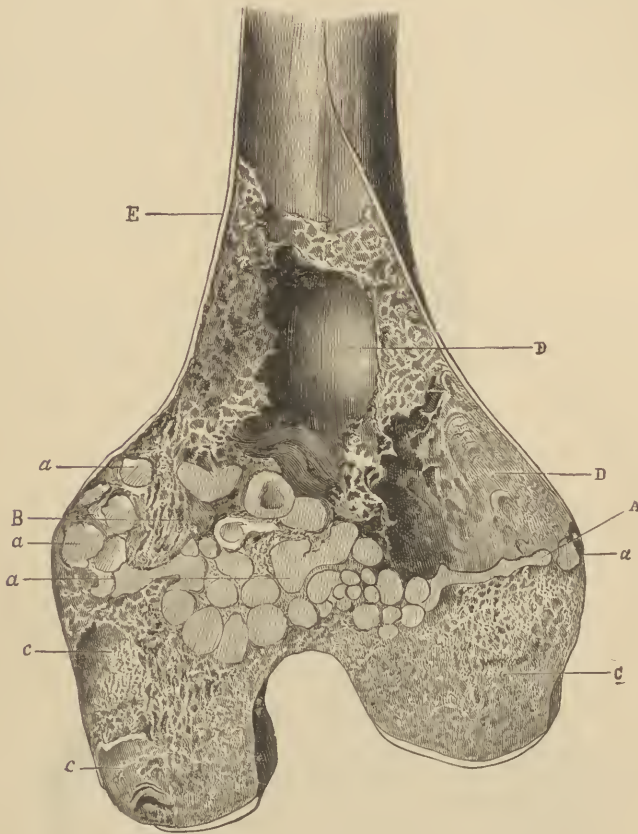
Treatment.—If knock-knee and scoliosis are dependent upon rachitis, one ought, no matter what surgical interference may be determined upon, to pay great attention to the general condition, and not to forget to prescribe the employment of phosphatic preparations, and of foods in which earthy salts predominate.

Although I do not have to treat here of the surgical therapeutics of idiopathic scoliosis, nor of that of knock-knee, I think I may in passing recom-

mend for scoliosis the method of Sayre; and for knock-knee the *redressement brusque* of Delore, of Lyons, or, better still—especially if the patient is over fourteen years old—subcondyloid osteoclasis with the apparatus and by the method of D. Mollière and of Robin, of Lyons, the magnificent results of which are multiplying every day.

LOCAL INFLAMMATORY RACHITIS.—It remains for me to mention a variety of rachitis in adolescents which is as yet but little known, I believe, and which may be called *local inflammatory rachitis*, in order to suggest the influence under which it is produced, and its limitation to the bone or bones

Fig. 789.



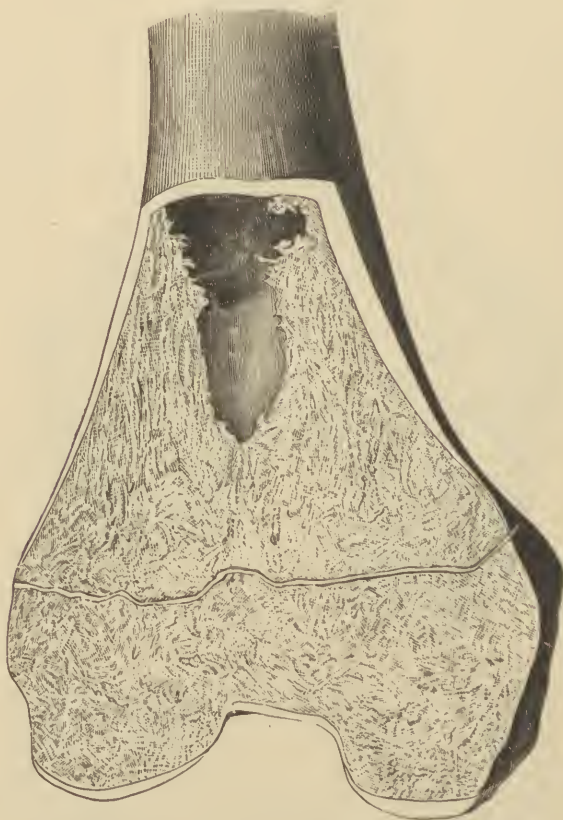
Specimen of local inflammatory rachitis of adolescents (late rachitis occurring in an inflamed bone, Ollier). Longitudinal section of the lower end of a femur, the upper end of which had been the seat of chronic osteitis in a case of coxalgia. *A*, connecting cartilage unbroken, but thicker than in the normal state; *a, a, a, a*, cartilaginous islets which have taken the place of the connecting cartilage and have invaded in an irregular way both the epiphysis and the diaphysis; *B*, spongy tissue which separates them; *C*, lower epiphysis, some points of which are medullized; *c, c*; *D, D*, medullized portions of the juxta-epiphyseal region of the diaphysis upon which rachitic chondro-spongioid proliferations encroach; *E*, compact tissue of the diaphysis as thin as paper, the medullary canal being very much enlarged.

inflamed. Inflammation (simple osteitis, tuberculous osteitis, caries, etc.) may cause at the other extremity of the bone, that not originally diseased, an arrest of ossification at the position of the connecting cartilage, together

with a defect of ossification in the subperiosteal osteogenic layers, and medullization of the old bone; whence arise the porous state of the spongy tissue and the thinning of the compact layer of the diaphysis. At the position of the connecting cartilage there is found only a thin rim of cartilage, with masses of cartilaginous nodules separated by spongy tissue and occupying a space of several centimetres. It is evident that these rachitic changes must be referred to the inflammation at a distance, to the disturbances of the circulation which it causes, and to the immobilization of the affected limb, and that they are further favored by the general malnutrition resulting from the constitutional condition and from want.

M. Ollier, who taught me to recognize this form of rachitis, has given me permission to republish the drawing made by M. Mondan, of a specimen which I found in his rich bone collection. The specimen was obtained from a young girl of fifteen years, who was treated by capillary puncture and immobilization for a suppurating coxalgia, and who, when she was almost cured of this articular affection, died in the Hôtel-Dieu with symptoms of tuberculous nephritis and meningitis. Figs. 789 and 790 represent longi-

Fig 790.



Longitudinal section of the healthy femur of the same patient.

tudinal sections of the lower end of the diseased femur and of the healthy femur, so that by contrast the rachitic changes which I have just described may be better understood.

It is probable that the lesions of rachitis are analogous in knock-knee and in the other forms of rachitis of adolescents; and that among the diseases of the bones and joints of young persons, local rachitis, caused by inflammation at a distance, is more frequent than is generally believed. The subject requires further investigation. This specimen may also be regarded as an example of rachitis combined with osteomalacia; for the cortical layer of the diaphysis was reduced to a thin flexible layer which was easily cut with the knife.¹

MORBID CONDITIONS IN WHICH BONE LOSES ITS NORMAL CONSISTENCE AND RESISTANCE; OSTEOMALACIA AND FRAGILITAS OSSIUM.

Besides rachitis, the bones may lose their normal consistence and power of resistance: (1) By true osteomalacia, general and progressive, to a certain extent malignant, usually puerperal; (2) By true osteomalacia, progressive also, but more slowly invading, to a certain degree benign (*osteitis deformans* of Paget); (3) By osteomalacia, dependent not upon any special constitutional cause, but upon an inflammatory cause which is wholly local (*osteitis*, necrosis with osseous new formations); (4) By atrophy of the bones (senile osteoporosis, fatty osteoporosis, etc.); and (5) By idiopathic fragility of the bones. I shall describe these different morbid states in the order of the classification which I have just given.

OSTEOMALACIA (*ὀστέον*, bone, *μαλακός*, soft) is a morbid process of softening of bone already formed, characterized histologically by "a lesion of nutrition of the bones which ends in absorption of the calcareous salts of the bone-substance and in melting away of the bony trabeculæ" (Ranvier); and clinically, by loss of the normal hardness and resistance of the bones, and by deformities of the skeleton which are more considerable as the softening is more marked.

History and Bibliography.—The first observation of osteomalacia, according to Lobstein,² was made by an Arabian physician by the name of Gschusius. This physician had seen a man—doubtless the augur Satih, whom J. Reiske³ calls the man without bones, and who died at about the time of the birth of Mahomet—a man who could move only his tongue, and who had himself carried upon a mat of palms, because he had no bones, except in his head, neck, and hands, and because the other parts of his skeleton, from his clavicle to his feet, bent like cloth. In 1851, M. Buisson collected⁴ fifty cases of osteomalacia, ancient as well as modern, which had been reported by Hallerius,⁵ J. Fernelius,⁶ Gabrieli,⁷ Prattenius (1660), Anel, Valsalva (1700), Morand the younger,⁸ Pringle,⁹ Ludwig,⁹ Planck,¹¹ J. P. Franck,¹² Sandifort,¹³ Wilson,¹⁴ and others.

In the writings of these different authors, the conception of osteomalacia as a morbid entity distinct from rachitis is far from clear. All sorts of softening:

¹ See pp. 848–852, *infra*.

² *Traité d'Anatomie Pathologique*, t. ii. 1829.

³ *Opuscula de re medica ex monumentis Arabum*, Obs. 2. Halæ, 1776.

⁴ *Thèse inaugurale*, 1851.

⁵ *De morbis internis*, Obs. 7. Lugduni, 1578.

⁶ *Universa medicina; de abditis morborum causis*, lib. ii. Genevæ, 1627.

⁷ *Miscellanea curiosa*. Obs. 3, 1695.

⁸ *Hist. et Mém. de l'Acad. des Sciences*, 1753.

⁹ *Philos. Trans.*, 1753.

¹⁰ *Adversaria medico-practica*. 1757.

¹¹ *Commentatio de osteosarcosi*. 1782.

¹² *De rachitide acuto adutorum*. 1788.

¹³ *Musæum anatomicum Academiae*. 1795.

¹⁴ *Diseases of the Bones and Joints*. London, 1820.

of the bones were confounded by the ancients. Glisson,¹ when studying rachitis in England, first marked a distinction which is supported no less by anatomy than by clinical experience, but Lobstein² was the first to assert the difference between osteomalacia and rachitis. Neither his contemporaries nor his successors shared all his opinions. Boyer³ described (under the title of *Ramollissement et fragilité des os*) rachitis, osteomalacia, and senile osteoporosis. The confusion was complete. Ruzf, in 1834,⁴ and Guérin, in 1839,⁵ devoted remarkable papers to rachitis, of which they traced, Guérin especially, the anatomico-pathological picture as no one had done before. Stanski⁶ (1839) represented osteomalacia as a separate affection. In 1850, Trousseau and Lasègue advocated with their usual ability the identity of the two diseases, and Gubler expressed the same opinion. The thesis of Buisson, in 1851, was a reply to these arguments, in which genius was more conspicuous than patient study. In 1852, Belyard collected 47 observations of *ramollissement* in adults.⁷ In 1861, the Gazette Médicale de Strasbourg published articles upon osteomalacia, signed by Schutzenberger and Sommeillier; and before the Faculty of Strasbourg, M. Drouineau,⁸ in reference to a patient of Professor Schutzenberger, laid down the differential diagnosis between osteomalacia and rachitis. But it would delay us too long to analyze the many papers written upon this subject. I must limit myself to mentioning the works enumerated in the note.⁹ With the accumulation of literature upon this question there ought not to be yet the least doubt about it. Unfortunately this is not the case. It is true that osteomalacia is not confounded nowadays with rachitis. One is a disease of adult life (decalcification of completely developed bones); the other is a disease of childhood and of adolescence (want of calcification of the proliferations of the cartilages of growth). But if an adult can only become osteomalacic, it is not certain that a child may not be at the same time rachitic and osteomalacic, or simply osteomalacic. Is the *osteitis deformans* of Paget a mitigated form of osteomalacia, or is it a real osteitis? What is the special agent of the morbid decalcification of the developed bones? What are the chemical and physical alterations of the different elements of bone? Here are some subjects for future study.

¹ Tract. de rachitide s. morbo puerili Rickets dicto. Lond., 1650.

³ Traité des Maladies Chirurgicales, 5e édition. Paris, 1844-1853.

⁶ Ibid., 1839.

⁷ Du rachitisme, de la fragilité des os, de l'ostéomalacie. Thèse, 1852.

⁸ De l'ostéomalacie. Thèse.

⁹ Curling, Medico-Chir. Transactions, 1837; C. O. Weber, Ossium mutat. osteomalacia univers effect. (Diss. Inaugural.) Bonn, 1851; Virchow, Archiv f. path. Anat., Bd. iv. 1852; Förster, Handb. der path. Anat., und Atlas, 1853; Rokitansky, Handb. der path. Anat., 1854; Alf. Collineau, De l'ostéomalacie en général. (Thèse.) Paris, 1859; Rindfleisch, Schweiz. Zeitschr. f. Heilk., Bd. iii.: Id., Traité d'Histologie Path., trad. par Gross. Paris, 1873; Kuhn, Parallèle entre les diverses espèces d'ostéom. (Gaz. Hebd., 1864); Vallin, Rachit. et ostéom. (Ibid., 1865); Volkmann, Hand. v. Billroth u. Pitha, 1865; Virchow, Pathologie Cellulaire, trad. par Picard, 4^e édition. Paris, 1874; Ranvier, Considér. sur le Dév. du Tissu Osseux. Paris, 1865; Cornil et Ranvier, Manuel d'Hist. Path., 1869.—Souligoux (Piorry), Ramollissement des Os, 1866; Ch. Robin, Comptes rendus de la Soc. de Biol., 1850, et Gazette Méd., 1851; Broca, Sur quelques points du rachitisme (Bull. Société Anat., 1852); Follin, Traité Élém. de Path. Externe, 1869; Nélaton, Éléments de Path. Chir., 1844, 1869; Dupuytren, Leçons Orales; Cruveilhier, Anat. Path. du Corps Humain. Paris, 1830-1842, in-fol., et Traité d'Anatomie Pathologique Générale. Paris, 1849-1864; Kilian (de Bonn) 1849 à 1857; Winckler, Roe, Calderini, Cazeaux, Crowhurst, 1870; Casati, Furstenberg, Wilmart, 1871; Barnes, Hugenberger, Ketzmaurwsky, Krassowsky, 1872; Gurtler, Hennig, Weber, Ebenhoff, 1873; Bouley, 1874; Langendorf and Mommsen, Beiträge zur Kenntniss der Osteomalacie (Virchow's Arch. f. path. Anat., Bd. lxi. 1876); Fasbender, Fehling, Banks, Mader, 1878; Feist, Grenser's Lehrb. der Geb.: Id., Nägele et Grenser, Traité de l'Art des Accouchements, 2^e édition, par Aubenas et Stoltz, p. 502. Paris, 1880; Atkins, 1880; Demange, Ribbert, 1881; Bancroft, Wolff, Rehn, 1882; Gusserow, 1883; Alph. Charpentier, Traité des Accouchements. Paris, 1883.

² Op. cit.

⁴ Gaz. Méd., 1834.

⁵ Thèse, 1839.

Pathological Anatomy.—I shall divide this study into three parts: 1st, physical properties; 2d, structure; 3d, chemical analysis.

1. *Physical Properties.*—The description of the physical properties of bones affected with osteomalacia includes: (1) their external appearance and the changes in their power of resistance; (2) the changes of direction which they undergo, in other words, deformities of the skeleton.

(1) *External Appearance and Changes of Power of Resistance.*—In mild cases, the bones may preserve their normal dimensions and color. But in typical cases it is said that their size and their color undergo alteration. They are grayish, dark brown, even purple. Some authors, Stanski among the number, have mentioned, as a constant occurrence, increase in size of the long bones and especially of their extremities, as in rachitis. This increase in size does not appear to me to be so common; it ought to be present when reparative processes have taken place under the periosteum, while chronic inflammation has caused absorption of the deep layers. Bulbous enlargement is not likely to be present except in young patients attacked with the malady during the period of growth. It is not possible for me to mention all the cases in which this enlargement has been observed. I will give only one as an example. Souligoux¹ mentions an enlargement near the head of the humerus. In analyzing this case, it is seen that the patient, who died at the age of 18 years, must have begun to be ill when about 15 years old, and that when about 6 or 8 years old he had a curvature of the spine. In his case the bulbous enlargement would seem to have been attributable rather to rachitis. I see no incompatibility in the coexistence of rachitis and osteomalacia. Why could not the same constitutional cause, during the period of growth, at once prevent calcification of the osteoid products of the cartilages of growth, and provoke decalcification of the bony parts already formed? I believe that this double action would be the more intense as the preformed bone was more recent, that is to say, the younger the patient was. The uncertain ideas which used to be held in regard to the growth of the bones lessens the value of the old observations. I have not found mention of these juxta-articular enlargements, in adults, in any recent observation. See, for example, the cases of Czerny, Langendorff and Mommsen² (man of 38 years); case of M. Mondan³ (woman of 48 years); case of M. Wolff (man of 26 years). As to the increase of size of the body of the bones, it may be admitted, strictly, that it may sometimes be real, that is to say, may result from subperiosteal proliferation. If, as everything seems to lead us to believe, osteomalacia is a kind of progressive chronic osteomyelitis, it is easy to understand this increase. For peripheral increase is one of the well-known signs of chronic osteomyelitis in general. In the cases which are usually examined, the processes of absorption and central medullization have reached their extreme limit, that is the disappearance of all bone-substance, old or new. It is only in cases of slight and localized osteomalacia, in which the process remains in a manner in the stage of onset, that a real increase in size of the body of the bone can be noted. If the cases published by Sir James Paget under the name of *osteitis deformans* are, as I am disposed to believe, slight and benign manifestations of osteomalacia, they furnish proof of the possibility of an increase in size of the bones in this disease. In the forms of osteomalacia which I call malignant—in contrast to *osteitis deformans* which does not lead to death, while classical osteomalacia is almost always fatal—the increase in size is only apparent, and is merely the result of the bendings and breakings which heap the bone upon itself. Usually, if there is still a shell of bone, with but few fractures, the bone will appear thinned rather than thickened.

¹ Op. cit., p. 114.

² Loc. cit.

³ Lyon Médical, 1876.

The surface of the bones which are not altogether absorbed, is honey-combed with openings, from which pressure causes drops of blood or a red material to well up. The periosteum which covers them is very vascular, thick, and adherent; when it is detached, laminae of bone are pulled off. The shell of bone which remains appears rugose, and is filled with holes which give it a spongy appearance.

The consistence of the bones varies with the degree of the disease. Sometimes they are as flexible as a wand, sometimes as soft as a bone which has been decalcified in acid, sometimes as soft as a muscle, or as a pulpy substance in which the finger can penetrate as in the tissue of the spleen, or of a hepatized lung. The knife always cuts them easily. But before they come to resemble rubber-tubes, the bones have remained a long time more or less resistant and elastic, though friable, it is true, and likely to break on the least strain. Kilian has advocated distinguishing two forms of osteomalacia: one characterized by friability of the bones (*Halisteresis fracturosa, psathyra*); the other characterized by softness (*Halisteresis flexibilis, absathyra coharens, cerea*). Such a division cannot be accepted unless it applies to a predominance of the character of flexibility or fragility; for there are found at the same time, and in the same patient, bones which may be bent like a reed, without breaking, until they describe a half circle, and others which break like glass at the least touch, upon the patient's sneezing, or upon his changing his position in bed. Cases of *halisteresis* exclusively of the fracturing kind, appear to me to pertain more legitimately to atrophy or idiopathic fragility of the bones.¹

The weight of the bones in osteomalacia diminishes simultaneously with their consistence. To what extent? The classical books do not say. Here are some figures taken from the paper of Langendorff and Mommsen. The cranium of the patient, which was at the occiput a centimetre (.39 inch) in thickness, weighed 370 grammes (8 lbs. Av.), including the lower jaw; while the normal cranium of a man weighs from 800 to 900 grammes (17.6–19.7 lbs. Av.). Of two equal pieces of the humerus, one from a patient with osteomalacia weighed 11.71 grammes (180 gr.); the other, taken from the body of a man of equal age who had died of acute tuberculosis, weighed 13.86 grammes (213 grs.); the mean difference was therefore 15.52 per cent. It cannot be objected, in regard to these weights, that the bone taken for comparison, from a phthisical patient, was ill chosen, because the bones of the phthisical are heavier. The increase in the density of the bones in phthisical patients, to which M. Charpy, director of the anatomical studies at Lyons, has given so much attention, is not constant on the one hand, and, on the other, is observed only in the chronic forms of phthisis.

The diminution of weight in osteomalacia is not constant. Bones may be found heavier in the first periods, and in certain slow forms of osteomalacia which do not pass beyond the first stage of the disease; for example, in cases analogous to those of Sir James Paget. Further, accoucheurs have noticed that some osteomalacic pelves are very light, whilst others are heavier than usual. Diminution or increase of weight depends upon the form or phase of the disease, at the moment of observation.

(2) *Deformities of the Skeleton*.—The constancy of these is such that they form an integral part of the symptoms of osteomalacia. A disorder which was absolutely free from them would not arouse a suspicion of the disease. Nevertheless, cases have been cited (Goodwin²) in which there were no deformities. It is not absolutely impossible that this may be the case in conditions where exceptional care is taken, and in a slight osteomalacia. But,

¹ See page 869, *infra*.

² Archives Gén. de Médecine.

with a few exceptions, deformities are the rule. They result from two causes: flexibility of the bones and their fracture. The direction of the bone is changed because it bends, or because it breaks. I have already said that we usually find in the same patient bones which are bent, and bones which are broken. The deformities do not always appear in the same parts of the skeleton. Kilian has given as pathognomonic the onset in the pelvis. It has been objected to him that the lower limbs are first and most affected, as in rachitis. These contradictions disappear if, after the example of Volkmann, we distinguish two categories of osteomalacia, one *puerperal*, the other *non-puerperal*. In the first the attack begins in the pelvis, in the second in the limbs. The fact that the lower limbs are first affected does not always justify the assertion, in an absolute way, that the disease has begun in them. Deformities appear more readily in the lower limbs, because the erect attitude and walking impose greater efforts upon them than the upper limbs habitually put forth. Usually the upper limbs do not become deformed until the patient (whom pain, and the difficulty or impossibility of locomotion have for a long time interdicted from all laborious work) is confined to bed. In turning, he breaks his ribs or his clavicles; in raising himself on his arms, he breaks his humerus. Still, there are cases in which the first deformities from fracture have taken place in the clavicles. (Mondan.)

I have no difficulty, however, in admitting that the disease *seems* ordinarily to begin in the lower limbs, in the non-puerperal forms. Perhaps, indeed, this beginning is real; the greater vascularity, the greater stasis of blood in the lower limbs, and their usually greater work, might account for this priority. But the bones in osteomalacia are not deformed by bendings and fractures alone; they are deformed also by shortening upon themselves. When the long bones are completely softened, retaining only thin bony plates in the epiphyses or diaphyses, and resembling fibrous cylinders, the tonicity of the muscles alone may suffice to shorten the limbs by drawing the ends of the bones together, which in this way close up upon themselves like Venetian lanterns. This drawing up in the longitudinal axis, aided by flexions and fractures—which may also be produced by muscular action alone, without the assistance of the weight of the body or of any external violence—is accompanied by an increase in size, more apparent than real, in the transverse direction; an increase which may be made to disappear altogether by drawing upon the two ends of the bone, when its normal length will be restored. Very often there is a diminution, both apparent and real, in the size of the long bones as well as in that of the short bones. As an example of the latter, see the osteomalacic pelvis represented in Fig. 791.¹

Before passing the deformities in review, region by region, I ought to say yet a word about the *fractures*. They are complete or incomplete; much oftener incomplete than fractures in healthy bones. They are distinguished from the latter by the absence of laceration in the periosteum, which depends less upon the thickness of this membrane than upon the slight degree of consistence of the bone, and especially upon the moderate cause which produces them. In the flat bones fractures do not involve the whole thickness of the part, and there is no displacement. The number of fractures or bends which may be met with in an osteomalacic skeleton is unlimited. M. Buisson has counted seventy-six fractures in one patient, and even more may be found;² M. Buisson says that the seventy-six fractures were all more or less consolidated by callus or by osteophytes. This leads me to speak of the consolidation of these fractures. Usually at the autopsy there is seen at their seat no reparative effort beside thickening of the periosteum, formation of fibro-

¹ See page 851, *infra*.

² Op. cit.

cartilaginous material, or simply plastic exudation between the fragments. Bony consolidation is seen only in benign forms, or in the early stages. After having examined a large number of cases, it seems to me that Volkmann has perhaps exaggerated the truth in the following statement: "Whatever may be said, these fractures usually heal without difficulty by bony callus, as in healthy individuals."

(a) *Bones of the Cranium and Face*.—The cranium may be rounded, or flattened laterally if the lateral decubitus is habitual. Usually it is but little deformed. Its sutures are effaced. The thickness of its walls is increased; in many cases it attains a thickness of from two to four lines (Souligoux),¹ one centimetre in the occipital region and seven millimetres in the temporal region (Mommson and Langendorff), one centimetre and a half in the region of the parietal bones (Mondan),² 14 to 16 lines in the region of the parietals, that is to say, four times the normal thickness (Paget).³

The two tables are hardly distinguishable from the diploë, which is composed of spongy tissue with large meshes, filled with yellow marrow. The frontal sinuses have been found very much diminished in size, and the sphenoidal sinuses obliterated, the digital depressions being shallow, while the grooves for the branches of the middle meningeal artery were deepened. At the same time that they become thickened, the bones of the cranium become softened; they may be cut with the scissors or a knife. In the case of the Marquis Bernard d'Armagnac⁴ they were said to be as soft as softened wax. The bones of the face are not always spared, they have been found thickened and softened, especially the lower jaw. Softening of this bone was present in different degrees in Souligoux's case, in which one part was soft, another spongy, another eburnated. All the teeth preserved their normal solidity—let us not forget that the patient was young.

It has been noticed that the lower jaw is constantly the last attacked. This is possible, because after this it would not be long before the patient died of starvation. The teeth it is said are usually not affected by the process, which would be explained by their different embryonic evolution. Nevertheless, Isenflam, Leblon, and Plenck, have found them also softened; Krause says that he has seen them cartilaginous. I believe that generally they cannot be found at all; for as the softened bones and gums fail to support them, they soon fall out.⁵

(b) *Vertebral Column*.—The spine is most commonly deformed by exaggeration of its normal curves. Cyphosis and cypho-scoliosis have been observed; but there may be the most unforeseen deviations, depending upon the degree of the softening and upon the parts of the column affected. The degree of shortening of the spinal column is proportioned to that of the abnormal flexions. It may be as great as thirty centimetres, which will be understood when the bodies of the vertebræ are seen reduced almost to their inter-vertebral disks. It is interesting to note that there has not yet been mentioned a diminution in the size of the vertebral canal, nor consequently any phenomenon of compression of the cord. Volkmann has seen the height reduced a foot and more in a few weeks, in consequence of diminution in the thickness of the bodies of the vertebræ, and of abnormal curvatures.

(c) *Clavicles*.—These bones break near their inner third, or are deformed by softening with exaggeration of their natural sigmoid curvature; the usual effect is to bring the shoulders together and to diminish the upper transverse diameter of the trunk.

¹ Op. cit., p. 108.

² Loc. cit., p. 8, and Plate IV.

³ Loc. cit., p. 119.

⁴ Mercure, Mars, 1007.

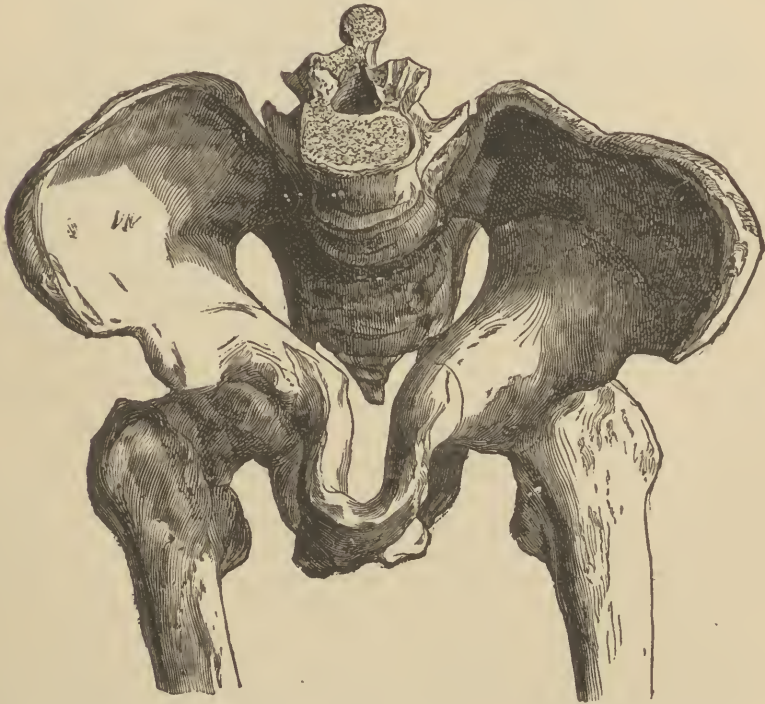
⁵ See Gusserow, Ueber das Ausfallen der Zähnen bei Osteomalacie. (Monatblatt f. Geb., Bd. xxiii.)

(d) *Ribs and Sternum, Thorax.*—The sternum and the ribs are the seat of a greater number of fractures than the other bones. The non-consolidation of these fractures, together with softening, causes the thorax to have, so to speak, no regular form; it takes that which is imposed upon it by position and by gravitation, as if the viscera were shut up in a cloth bag. When the patient is lying down upon his back, the transverse diameter is increased; the thorax is flattened, the belly spreads out, and this effect is the more manifest because the trunk is shortened and crowded together, in consequence of the sinking down and deviations of the spinal column. When the patient lies upon his flanks, the antero-posterior diameter is the longer, and the sternum makes a very marked prominence in front, so that the appearance of the thorax recalls the conformation of a pigeon's breast, to which the breast of the osteomalacic is commonly compared.

(e) *Scapulae.*—The scapulae are drawn forward by the shortening of the clavicles, they are separated behind, and become prominent; for which reason they are called "winged." They are twisted around the thorax by the action of the muscles, and so present a greater depression in front.

(f) *Pelvis.*—This presents the most typical deformities, according to Volkmann; they at least attract the most attention from accoucheurs, who are

Fig. 791.



Pelvis, osteomalacic to the highest degree. The woman succumbed to the progress of the disease.
(Stoltz's collection.)

particularly interested in the recognition of osteomalacia. According to M. Charpentier,¹ the following are the characteristics of the osteomalacic pelvis (see Fig. 791): "The wings of the ilium, which are sometimes small and

¹ *Traité d'accouchements.* Paris, 1883.

transparent, and have usually lost their shape and their normal thickness, bend, are curved upon themselves like a horn, and have a groove, a fossa, which is directed from above downwards, and which is ordinarily single, though sometimes bifurcated. The cotyloid cavities are pressed back by the femurs, and are pushed upwards, forwards, and inwards, thus approaching one another and the promontory of the sacrum. The horizontal rami of the pubic bones approach each other and become almost parallel, leaving between them a single narrow interval at the upper part, which is not much larger below where the ascending rami of the ischia and the descending rami of the pubic bones have undergone the same change of position, giving the symphysis the shape of a sort of duck's bill protruding in front of the pelvic ring. The pubic arch thus disappears, and is replaced by a kind of deep and narrow fissure into which the finger penetrates with difficulty."

The tuberosities of the ischia are forced far inwards; the sacrum is, as it were, doubled upon itself in the vertical and transverse directions; the lumbar part of the spinal column, in consequence of the descent of the promontory, forms a prominence which in its turn narrows the superior strait. "Thus doubled up and pushed in upon itself, the pelvis presents a strange appearance, which has led to its being compared to a three-cornered hat." Every part is affected by the deformity—the superior strait, the inferior strait, the cavity—and often in such proportions that the diameters are reduced to an unimaginable narrowness. As Depaul has well said, the pelvis has a *rumpled* appearance.

It is not necessary for a woman to remain upright or seated in order that the osteomalacic pelvis shall assume these characteristics. The lateral decubitus, alternating from one side to the other, produces an effect analogous to that of the upright position, by pushing in the trochanters. Nor is it in women only that the pelvis is deformed; it becomes deformed also in men; but only in women has osteomalacia been seen to be localized in the bony pelvis.

(g) *Upper Limbs*.—The humerus is curved forwards by the action of the deltoid; in some cases it has taken the shape of the letter Z, in others that of S; fractures and flexions combine to bring about such deformities. The bones of the forearm are more rarely deformed. The bones of the hand have been seen to be spongy and fragile; but I do not find a deformity of the end of the fingers reported except in the case of Czerny, published by Landgendorff and Mommsen; the ungual phalanges were club-shaped, and the nails were three times as broad as they were long.

(h) *Bones of the Lower Limbs*.—Like the other bones, these are deformed by exaggeration of their normal curves; the femur curves forwards and outwards, the tibia becomes twisted and also curves forwards, the feet are extended by pressure of the bedclothes, and are shortened. To these deformities, due to softening and weakness of the bones, are joined those which result from fractures, to which the lower are more exposed than the upper limbs. So many influences may affect these deformities that they actually baffle description. As an example of an extreme type, I reproduce (Fig. 792), a picture of the *femme Supiot*, from the drawing of Morand fils, a glance at which will tell more than a description which would always be incomplete in spite of its length, because it could not include all the features of all the isolated cases.

2. *Structure*.—Bones affected with osteomalacia present on section an appearance which varies according to the degree of the affection. At the beginning their structure appears but little altered, but afterwards the spongy portions rarefy progressively, and the compact portions become filled with alveoli. The enlarged spaces of the spongy tissue of the bone lose their normal medulla,

and little by little are filled with a sanious or reddish, sometimes colorless, liquid, "showing all degrees of ecchymosis, sometimes gelatinous and even

Fig. 792.



La femme Supiot. (Fac-simile of the drawing of Morand in the Mém. de l'Académie des Sciences, t. xxii. 1753.)

pulpy. The medullary canal is in some cases obliterated by the separation of the fibres."¹ Figure 798² represents a section of a femur from a case of *osteitis deformans*, of Paget. Is this not exactly what has been described here by Nélaton in speaking of osteomalacia? We cannot discuss this mode of filling up of the medullary canal, or affirm whether it is obliterated by tissue of new formation, or by separation of the lamellæ of the compact tissue by interstitial medullization. However this may be, if what Nélaton describes may be met with in the beginning, it is certain that, in the last stages of the disease, the medullary canal enlarges enormously, that all the bone-substance sometimes disappears, and that "there remains of the bone nothing but a sort of thin external pellicle, analogous to the shell of an egg." (Nélaton.) The mass contained in the osteo-membranous sac which replaces the bone in the last stages, resembles a dregs-of-wine-colored jelly more than marrow; it is a sort of fleshy parenchymatous substance which recalls to the observer the tissue of the liver, of the gums, of the brain-pulp, of the pulp of the spleen, etc. This diffuent material usually has scattered through it cysts,

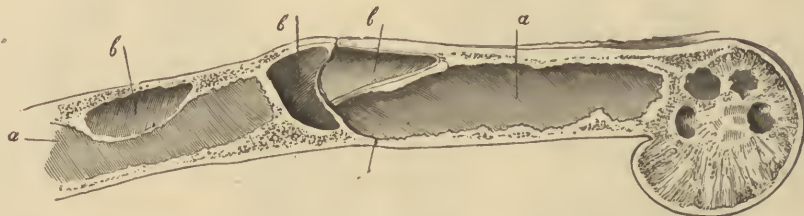
¹ Nélaton, op. cit., p. 634.

² See page 866, *infra*.

which may have a diameter of an inch, inclosing a sanious, yellow, oily, serous, sometimes even purulent liquid, "which gives the tissue the appearance of Holland cheese." (Souligoux's case.¹)

Cruveilhier thought that these cavities resulted from dilatation of the veins. But it cannot be so, because injections driven into the veins do not reach these cysts. It is more probable that they owe their origin to hemorrhages more or less completely absorbed. They are lined with a smooth white membrane in which no vessels can be discovered. The periosteum may itself be found to be infiltrated with a sanguinolent material; the joints usually remain unaffected, the cartilages likewise. Yet a number of observers say that they have seen them softened. Perhaps compression and immobilization were the true causes of this. The flesh which surrounds the diseased bones is œdematous and flabby; the muscles pale, anæmic, atrophied, stretched or retracted, according to the deformity of the limbs. As for the viscera—the lungs, heart, spleen, liver, kidney, etc.—they present, as far as the osteomalacia is concerned, only secondary alterations, resulting from the mechanical interference with their functions induced by the sinking in of the portions of the skeleton which protect them. In some cases absence of cadaveric rigidity has been noticed. In a large number the account of the necropsy mentions the presence of calculi in the kidneys or bladder.

Fig. 793.



Section of osteomalacic humerus (left). *a*, enlarged medullary canal; *b, b, b*, cysts or spaces of the medullary canal; *c, c*, line of fracture dividing one of these cysts. (Mommson, Pl. XVIII.)

Our knowledge of the minute alterations of the bone-tissue in osteomalacia is due especially to the labors of Virchow, Volkmann, Winckel, Schieck, Weber, Rokitsansky, Rindfleisch, and Cornil and Ranvier. The following is the account given by the latter:² "In the first stage of alteration the bones have preserved their size and do not exhibit any rarefaction; nevertheless they may be divided with a cutting instrument. At this stage, it may be observed in histological preparations, that the centres of the osseous trabeculae still contain calcareous salts, whilst their borders are completely devoid of them. Only the latter parts are colored by carmine, according to Rindfleisch. It is indeed known that undecalcified bones do not take up carmine. The bone-corpuscles are such as are found in preparations of bones decalcified in chromic or hydrochloric acid. The vessels of the medulla are filled with blood. The fat-cells are less numerous than usual, and in their place there are developed round or irregular cells, sometimes fusiform or flattened. Soon the medulla is the seat of diffuse hemorrhages, which are seen in the form of ecchymotic stains or patches. Hemorrhages may also occur under the periosteum, which is now only slightly adherent to the subjacent bone-tissue. In the second stage, the bones become considerably deformed. In this second stage the bone-trabeculae are not only decalcified throughout, but even in large part absorbed. The enlarged medullary spaces are filled with

¹ Souligoux, op. cit., p. 113.

² *Traité d'Histologie Pathologique*, t. i. p. 387.

fœtal medulla, which has the appearance of the splenic pulp. There is also found constantly in the medullary cells, coloring matter, in the form of yellow or brown pigment. This pigmentation of the cells is caused by the extravasations of blood which have been already mentioned."

In Fig. 794 I give a histological section. In it will be noticed the enlargement of the Haversian canals, the semilunar scalloping of their edges, which are eroded as in osteitis. The Germans lay great stress upon the presence of multinuclear cells (the *osteoclasts* of Kölliker, of Wegner, of Roki-

Fig. 794.



Section of osteomalacic humerus, decalcified with dilute nitric acid. (Hartnack, Syst. vii. oc. 3.) *a, a*, enlarged Haversian canals, with vessels in section; *b*, slightly altered bone-substance; *c*, lacunæ of Howship with small cells; *d*, fusiform elements; *e*, lines uniting indistinct lamellar systems; *f*, periosteum. (Fig. 6, Czerny's case, in Langendorff and Mommsen's Memoir.)

tansky, and of others; the *myeloplaxes* of Robin) in the so-called lacunæ of Howship. Kölliker, Wegner, and Langendorff and Mommsen, have seen particles of lime in these cells, whence their idea of attributing to the giant-cells an active part in osteomalacia. Further, it is to them that they attri-

bute all the phenomena of absorption of which bone-tissue may be the theatre.¹ It is interesting to note that Durham, Langendorff and Mommsen, and others, have noticed points of sclerosis in osteomalacic bones (Fig. 793).

It is generally recognized that the bone-corpuscles have no vital activity and act like inert bodies. J. Busch went so far as to believe that the osteoblast changed into an osteoclast in order to destroy its own work, like Penelope. Here are hypotheses enough; histology has still much to do. The only points yet gained are that decalcification starts in the Haversian canals and extends progressively to the whole system of lamellæ of which these are the centres; that their edges are eroded as in ordinary osteitis; and that the medulla increases in quantity and reverts to the foetal condition.

3. *Chemical Analysis of the Bones.*—All analyses (Becquerel, Davy, Rostock, Rees and Buisson, Marchand, Schmidt, O. Weber, Langendorff and Mommsen, etc.) have furnished this uniform result, to wit, that the calcareous constituents are diminished in proportions which are always considerable, and which vary with the degree of the osteomalacia. The diminution of the earthy parts affects especially the phosphate of lime. According to Davy, the organic constituents bear to the calcareous the proportion of 74 to 26; according to Rostock of 79 to 20. Rees has investigated this proportion in the majority of the bones separately. I shall not reproduce more figures here, because figures cannot give any positive idea, on account of the varying degrees of softening in the bones examined by different chemists.

It has been long known that osteomalacic bones are fat; they are oily, says Buisson. When exposed to the air, considerable quantities of fatty matter exude from their pores. I have at this moment a beautiful example of this under my eyes. It might be thought to be a specimen of gouty osteophytes. Mommsen, after having treated them with ether, found fat in the bones of Czerny's patient in the proportion of 60.38 to 100 parts, instead of 24.31, which is the normal figure.

The augmentation of the fat which takes the place of the bone-tissue is therefore enormous. But these figures must not be made a basis of generalization; they are exact only for the special cases which furnished them. The same observer, and in the same case, found, by calcination, in 100 parts of the ashes of normal bone, lime = 53.05; phosphoric acid = 43.98; and in 100 parts of the ash of an osteomalacic bone, lime = 44.48; phosphoric acid = 34.76. In bones which are much altered there is no longer any trace of glutine or chondrine found. Sometimes the marrow is acid, sometimes it is alkaline or neutral; this depends on the presence or absence of the abnormal acid (lactic) of which I shall soon speak.

Among the abnormal substances which chemical analysis has discovered, I will call to mind the opaque albuminous bodies of Bence-Jones, found in the medulla by Virchow;² and lactic acid, the presence of which has been observed by Marchand and by C. Schmidt.³ O. Weber,⁴ Mærs and Muck,⁵ and Mommsen⁶ have not found either the deutoxyhydrate of albumen (identical with the tritoxypoteine of Mulder) or lactic acid.

Symptomatology of Osteomalacia.—Whatever may be the form of osteomalacia, the symptoms which accompany it depend either directly upon the nature of the affection, or secondarily on disturbances of the functions of different organs. The onset is always marked by more or less acute pains, which are increased at night by the warmth of the bed, and which last while

¹ E. Vincent, De quelques travaux récents sur le système osseux (Revue Mensuelle de Médecine et de Chirurgie, 1880).

² Virchow, Archiv, 1852.

⁴ Weber, Archiv, Bd. xxxiv.

⁶ Mommsen, loc. cit.

³ Ann. d. Chemie, Bd. lxi.

⁵ Deutsch. Arch. f. klin. Med., Bd. v.

the process is advancing. Movement and pressure make them more acute. Before the appearance of the deformities due to breaking or bending, they are almost always attributed to rheumatism, which they simulate. The seat of pain varies, naturally, according to the bones affected. In puerperal osteomalacia, that which is observed in women who have borne children, generally in large number, the pains almost always begin in the pelvis. One or both of the ischiatic tuberosities become painful; thence the pain travels to the symphysis, and to the spine of the ischium, then to the other bones of the pelvis, the sacrum, and the lower lumbar vertebræ. Very often the coxo-femoral joints become painful; then motion of the thighs is difficult; walking is impeded, if it is still possible; in women, inability to abduct the thighs is characteristic. (Volkman.) The shoulders are attacked in turn, and finally the limbs, the thorax, and the head share in the general affection. Locomotion, from being painful, becomes impossible; sitting down soon becomes too much for the strength of the patients, who, in order to avoid the pain caused by movement of the joints and bones, and by fatigue, condemn themselves to as complete immobility as possible. Finally, they are confined to bed, where they enjoy only comparative repose. The sensitiveness of the ischia, and of the sacral and lumbar vertebræ, does not permit them to remain long seated or lying upon the back; they lie sometimes on one side, sometimes on the other, finding no position comfortable. At the end they are seen to assume the most strange positions. Doubled up upon themselves, reduced in length by the shortening of the spinal column and limbs, they come to be only shapeless and whining masses of flesh. The poor creatures suffer continuously, and cannot move to supply any need without the help of others, and without risk of breaking some of their bones.

I have described above the deformities of the skeleton. "It has been said that the pains subside from the moment when the curvatures occur, but this phenomenon is far from being constant." (Nélaton.) Besides, when the pains which depend upon progressive osteomyelitis or fracture disappear, the deformities of the trunk and limbs are the cause of much discomfort and suffering, dependent upon functional disturbances of the viscera—the lungs, heart, stomach, digestive canal, etc. M. Gusserow mentions, as characteristic of the disease, the sulky and morose physiognomy of women. It will be admitted that they have little cause to be smiling. As an evidence of the nervous irritability of these patients, Lobstein mentions a woman whom it put in a bad humor to see a cambric handkerchief waved before her, while at the same time it brought on a fit of pains in all her limbs.

In *non-puerperal* cases, osteomalacia usually starts in the vertebral column and the thorax, according to Volkman. The bones of the pelvis may sometimes remain entirely free, or at least so little changed that they are not deformed. The disease shows a peculiar disposition to extend to the greater part of the skeleton, to the limbs, and even to the cranium. It has been said that the cranium is rarely affected. In the majority of recent observations the walls of this cavity have been found much thickened, even in the *osteitis deformans* of Paget. (See pp. 865, 866.) The puerperal form is relatively more frequently limited to the pelvis and to the lower segment of the vertebral column. Consequently, the progressive non-puerperal form may, in a general way, be considered the more grave. (Volkman.) This may be only because women do not live long enough to go through the entire evolution of the disease. A large number succumb to the complications of pregnancy and child-birth, or to the operative measures undertaken to deliver them at the time of parturition. Nevertheless, the cases in which delivery has been accomplished, either by the efforts of nature alone or by the assistance of art, are not extraordinarily rare. Osteomalacia demands Cæsarean

section less frequently than one would believe. The great softness of the pelvis lends itself to the spontaneous or assisted passage of the foetal head. Kilian, Robert, Schmitz, Hugenberger, Olshausen, Kezmarsky, Breslau, Fasbender, Pullen, Krassowsky, Winckel, Schieck, Weber, and Ebenhoff have found, during life and in the cadaver, pelvis so distensible as to be expanded by the foetal head like India-rubber, to which Schieck has given the name *Gummi-Becken*, India-rubber pelvis or elastic pelvis.

In both forms, puerperal and non-puerperal, when osteomalacia passes through its extreme stages, the most varied functional disturbances are seen to be added to the disorders already mentioned in connection with the locomotor apparatus.

Dyspnœa comes on and increases, as well as bronchitis and congestion of the lungs. The circulation becomes more and more disturbed, in proportion as the deformities of the trunk increase the interference with the functions of the lungs, of the heart, and of the large vessels. In the *femme Schœff*, the arch of the aorta had a double curve (Th. Drouineau).

The imperfect supply of blood, the anæmia due to confinement to bed and to insufficient assimilation, and the mechanical obstacles to the return of the blood, cause œdema of the limbs, and of the dependent parts, and render the patients dropsical. (Volkmann.) The digestive functions are disturbed also, for the same reasons which lead to anæmia and cachectic œdema. The patients often have diarrhœa and vomiting towards the end; cachectic fever comes on, and after a variable time—generally a long one—after having been better and worse intermittently, the patients succumb in a state of marasmus. Sometimes thrombosis ends the scene suddenly. In the last stages of the disease there are often profuse sweats. I have already spoken of the effect of softening of the lower jaw, which renders mastication impossible, and so hastens death; that is, of course, provided that the patient is not nourished with liquid food, and, if necessary, by the œsophageal tube and with nutritious enemata. The Marquise d'Armagnac lived a long time on liquids. Dujet reports that he saw a squirrel die of starvation, being affected with osteomalacia and unable to crack its food.

The *intelligence* ordinarily remains unaffected in the midst of this decadence of the organism, in spite even of the participation of the cranium in the disease. Yet there are cases in which the subjects have shown some imbecility or dementia towards the end. Such, for example, was Czerny's case. At the autopsy, both hemispheres of the brain were found to be hyperæmic, with superficial ecchymoses, enlargement of the ventricles, etc. Finkelburg¹ saw two cases of osteomalacia, following parturition, in which the patients were attacked with melancholy, and afterwards with incurable mania, with a predominance of hallucinations of hearing. It was thought that these psychical disturbances were caused by compression of the brain by the basilar process of the occipital bone, which was pressed up against the brain in consequence of the softening of the neighboring bones.

I have not spoken yet of the *state of the urine*, which has a certain position in the clinical picture of this disease. Since the phosphates are lessened in the bones, they must be eliminated from the organism, or take refuge somewhere (accidental calcifications, renal and vesical calculi). The most natural route of elimination being that of the urine, it is not astonishing that this excrementitious liquid often contains an excess of phosphates. Litzmann has also found in it an excess of carbonates. Billroth says that the phosphates which pass into the blood are eliminated from it in great part in the form of oxalate of lime. Other equally conscientious observers have arrived at opposite

¹ Osteomal. mit Irrensein (Allg. Zeit. f. Psychiatrie, Bd. xviii.).

results. Schützenberger, Møers and Muck, and Volkmann, have not found any increase in the phosphates. Pagenstecher even found a diminution of the earthy salts in cases which progressed rapidly. Langendorff and Mommsen also have seen a considerable diminution of the phosphates. These differences may be explained in two different ways. Phosphates have not been found in excess in the urine, because the examination was made during a period of calm. They have been found diminished, because, the work of decalcification being ended, there was no or scarcely any bone left; and because, being deprived of this source of supply, the combustion of the organism would necessarily be characterized by a lessened phosphatic waste. The other explanation would be to say that the earthy salts were eliminated by other secretions or excretions than the urine; by the sweat, by the tears, or by the saliva. It has indeed been observed in some cases that these liquids, when allowed to stand, deposited a white sediment like that of the urine. In nursing women, might not the milk also be an important route of elimination? Pagenstecher did not find, it is true, any excess of phosphates in the milk, but he did not find it anywhere in his patients. This is a point to be verified, like so many others, in this difficult and complex subject of osteomalacia. Pagenstecher believes that the principal route of elimination is the bronchial and intestinal mucous membranes; and that thence arise the pulmonary catarrh, the digestive disorders, and the diarrhœa which are almost constant in this disease. It would be well in future to analyze the urine, and all the excretions and secretions from the beginning to the end. The great difficulty would be to establish a diagnosis soon enough. However it may be in regard to the constancy and degree of elimination of phosphates by the urine, there have been observed in several cases phosphatic deposits in this fluid, renal gravel, and calculi in the bladder.

Among the abnormal substances in the urine, chemical analysis has also revealed a substance which its finders have called deutoxydhydrate of albumen. (Prout and Bence-Jones.¹) Mommsen has thrice found the ordinary reaction with albumen, and at other times the reaction attributed to the deutoxydhydrate.² The presence of albumen might be due solely to a calculous nephritis. More important in the interpretation of osteomalacia is the presence of lactic acid in the urine. It was first noted by Møers and Muck,³ according to Mommsen. Its quantity varies with the severity of the disease. Mommsen found lactic acid in treating the urine of the patient of Czerny by the method of Hoppe-Seyler (whiting, alcohol, sulphuric acid, ether, oxide of zinc). But what somewhat impairs the value of these observations is the fact that normal urine sometimes contains lactic acid. (Lehmann, Brucke, Mommsen.⁴) Brucke believes even that to this substance should be partly attributed the acid reaction of normal urine.

Etiology and Nature of Osteomalacia.—The etiology and nature of osteomalacia are full of obscurity. There are distinguished three orders of causes:—

1. *Predisposing Causes.* (1) *Age.*—It is said to be rarely observed below twenty years. Nélaton says that the cases of osteomalacia which are believed to have been seen in the new-born were very probably only cases of rachitis. Nevertheless, if by the term osteomalacia is understood the softening of already existing portions of bone, the possibility of its occurrence even in the new-born and in children, must be admitted. I have under observation at the present time, at La Charité, in a little girl twenty-one months old, a case of softening of the diaphyses of both femora and of both humeri, which

¹ Lancet, 1847.

³ Deutsch. Arch. f. klin. Med., Bd. v.

² Mommsen, loc. cit., p. 14.

⁴ Mommsen, loc. cit., p. 16.

I can attribute only to osteomalacia. Dr. Rehn, of Frankfort, made at the fifty-fifth reunion of the *Curiosi Naturæ*, a communication on infantile osteomalacia.¹ Recklinghausen and Rehn have seen several of these cases. From the microscopical point of view, the bones present the same changes as those of adults; the osseous trabeculae are almost entirely deprived of calcareous salts. In the epiphyses there is an extremely slight rachitic condition. The most remarkable fact is the extreme softness of the bones. Macroscopically and clinically, infantile osteomalacia is characterized by slenderness of the skeleton, the abnormal flexibility of the long bones coinciding with absence or insignificance of the epiphyseal enlargement, which is scarcely perceptible on the ribs. The bones of the legs, thighs, forearms, and arms, and the ribs, show curvatures. When the bones are touched or the children are made to walk, unquestionable manifestations of pain are provoked. Examination of the urine does not disclose anything noteworthy. It is important to observe that all the children traced or examined by Recklinghausen and Rehn, were of the female sex and in their second year. The prognosis is better than in adults. Good nourishment, preparations of iron and of the phosphates, and cod-liver oil, have enabled M. Rehn to save three patients out of four. It cannot be objected, with M. Fleisch, that these were simple cases of rachitis. The histological examination made by Recklinghausen having disclosed the decalcification peculiar to osteomalacia, and the cases followed by recovery having presented the same set of symptoms (except death) as those which ended fatally, it seems to me that we are not authorized to reject the diagnosis of infantile osteomalacia without further ceremony. Physicians and surgeons who devote themselves to diseases of children ought in future to give their attention to this point.

(2) *Sex*.—Statistics show a notably greater frequency in the female sex. The proportion of 13 females to 3 males has been found by Gaspari; of 20 to 1, by Marjolin; of 36 to 11, by Beylard; of 4 to 1, by Drouineau; of 10 to 3, by Nélaton. In women it is ordinarily after a number of confinements that the disease manifests itself. According to Kilian, no less than five confinements are necessary to give rise to the disease in women predisposed to it, but observation has since shown that sometimes a single pregnancy suffices to give rise to osteomalacia, even in its gravest form. According to all observers, pregnancy is, of all known causes, that of which the influence is the most potent and the most incontestable. Of 36 women affected with this mysterious disease, Drouineau found 15 who had had children, and he noticed that those who were primiparae had not become pregnant until about thirty years of age.

(3) *Climate*.—Osteomalacia has been seen in all latitudes. It is very rare in England, according to Curling; quite common on the shores of the Rhine and in the valleys associated with the basin of that river, according to Volkmann. It is often observed in Bavaria, in northern Italy, and in Flanders. In Norway, according to Prosch, the plant called *Herba ossifraga* has the property of softening the bones of animals which eat it. They can be cured by mixing calcined bone-dust with their food.

(4) *Heredity*.—There are very few facts to show the influence of this upon osteomalacia. The observation of Eckmann² is always cited. This author reports that in a family which lived among the iron mines of Danemora, in Upland, there could be counted three generations, the different members of which were attacked, after puberty, with softening, fragility, and distortion of the bones. No one in this family had been affected with vene-

¹ Ueber Osteom. im Kinderalter (Berlin. klin. Woch., S. 706. 1882).

² Dissert. med. desc. et casus aliquot osteomalaciæ sistens. Upsal, 1788.

real disease. They did not live in a marshy country; their food was similar to that of the other miners. The first member of this family of deformities, Nicholas Ecroth, who is said to have died rachitic, had healthy parents who had worked in the same mines.

2. *Hygienic Causes*.—As osteomalacia is more rarely seen among the rich than among the poor, it has been concluded that poor food and poor hygienic conditions contribute to produce it. Everything which weakens the organism, everything which impairs its nutrition, favors the occurrence of the disease; bad food, hard work, privations of all sorts, damp and ill-ventilated dwellings.

3. *Pathological Causes*.—Does rheumatism prepare the way for osteomalacia? It is more probable that the pains belonging to osteomalacia have been confounded with those of rheumatism. All cachexias have been looked upon as predisposing causes: syphilis, scurvy, diabetes, cancer, etc. The disease has also been attributed to onanism, to the abuse of mercury, to metastasis, etc.

4. *Proximate Cause*.—This is still unknown, although many hypotheses have been put forth in regard to the essential, proximate cause of osteomalacia. Let us see what they are worth. Ilérissant, having softened bones in the oily fluid from carious bones of syphilitic or scorbutic patients, concluded that osteomalacia was due to the presence of a rancid and putrefied oil. Navier¹ expressed the idea (it is old, we see) that the bones must be softened by an acid. Renard² spoke of the excess of phosphoric acid, an hypothesis which has been revived in our days. Stanski says that the presence of this acid in the body has not been demonstrated, and asks whether, in addition to the disappearance of the lime-salts, there is not a change of structure and a degeneration of the bone-tissue, and, like Gaspari, he refers the softening to an inflammation; in support of which opinion he mentions the violent pains, the general heat, the swelling and easy separation of the periosteum, and the liquefaction of the hyperæmic medulla. Eckmann³ supposes an innate feebleness of the digestive organs which does not permit the nourishment of the bones. Morand, the younger, believes that the bony juices do not reach the bones and escape by the urine, and he cites as an evidence the white deposit which forms in this liquid, and the presence of stones in the bladder. Pravaz,⁴ rightly supposing the presence of lymphatics in the bones, says that by exaggerated activity they take up too much of the calcareous material. This is a rational hypothesis, but there is nothing to prove it. Drouineau recognizes the inflammatory nature of osteomalacia. It is an osteitis which simply has some peculiar features. Rindfleisch regards osteomalacia as resulting from venous hyperæmia or premature senility of the bones. He has shown that the bone-tissue resembles that from which the lime has been removed by hydrochloric acid, and that the liquefaction proceeds from within outwards in the Haversian canals, making réentrant angles, lacunæ of Howship, "such as are seen in the line of absorption in inflammations, in caries, etc." He recognizes a passive hyperæmia going on to stasis. "I could even understand," he says, "that the blood retained in the marrow of the bone might produce there a greater quantity of carbonic acid, and that this acid would serve to dissolve the lime salts." But this, says Ranvier, "is only an ingenious notion."

We have seen that Marchand, Schmidt, and Weber had several times detected the presence of lactic acid or lactate of lime in osteomalacic bones. Hence the hypothesis of the morbid production of lactic acid as the etiological basis of the process. But it remained still to know why this acid was in excess.

¹ Observ. sur le ramollissement des os. Paris, 1755.

² Ramoll. remarq. des os d'une femme. 1804.

³ Loc. cit.

⁴ Déviation de la colonne vertébrale.

This hypothesis has received considerable support from experimentation. Heitzmann has made herbivorous and carnivorous animals ingest lactic acid. The following are his conclusions: "The result of my experiments on the continued administration of lactic acid, is that, in carnivora, there are artificially produced, at first, rachitis, and afterwards osteomalacia; whilst in herbivora osteomalacia is seen to occur without the symptoms of rachitis having preceded it. Lactic acid, in contact with the osteogenic regions, or with completely developed bone, manifests its great affinity for lime, and succeeds either in preventing the formation of bone (rachitis), or in dissolving the bone already formed (osteomalacia)."

Experiments on animals and clinical observations are still needed in order to be certain in regard to the part of lactic acid in osteomalacia. Is it cause, or is it effect? This is the question for it as for the microbes in so many diseases, tuberculosis among others.

Diagnosis of Osteomalacia.—This can be deduced naturally from what has already been said, and from what I shall add about the osteitis deformans of Paget (which I call benign hypertrophic osteomalacia), about the pseudo-malacia of young bones or of bones medullized by inflammation, about atrophy of bones (senile and fatty osteoporosis), and about idiopathic fragility of bones. I will only speak here of the differential diagnosis from some diseases with which osteomalacia has been confounded, and which I have not described.

(1) *Rheumatism* is hard to distinguish from osteomalacia at the beginning. There are the same intermittent, shifting pains. But by paying some attention to them, it will be noticed that in rheumatism the pains are less acute, and that they commence rather in the joints, or in the muscular masses, and not deep in the course of the bones. In rheumatism the urine contains urates in excess, in osteomalacia it often deposits phosphates.

(2) *Syphilis* can give rise only to osteitis and periostitis which deform the bone by hyperostosis or by fracture (bone-gumma). Curvature from simple syphilitic softening is rare, if indeed it has ever been seen. The history and course of the disease will dissipate any doubts which may exist at the first examination.

(3) *Myelitis* could only lead to hesitation in case of osteomalacia beginning in the spinal column; but in myelitis, spinal pains, yielding, and curvature of the column, are not the dominant symptoms. There may be weakness in the lower limbs, lightning-pains, formication, and cutaneous anæsthesia. If there be locomotor ataxia, the gait will be abrupt and irregular, and not tottering as in osteomalacia affecting the lower limbs. Finally, there is neither deformity of the limbs by bending or by fracture, nor diminution of the stature.

(4) The *nervous osteopathies* also are not characterized by bending of the long bones; the articular extremities undergo a process of wasting, which deforms them and causes them more or less to disappear, being sometimes accompanied by colossal hydrarthrosis (of which I have seen one case, in the knee, in a neurotic patient with the morphia habit), and it gives rise to deformities which are distinguished from those of osteomalacia by being situated in the joints.

(5) *Pott's disease* has been confounded with osteomalacia through errors of belief rather than of clinical observation. Thus Piorry and Souligoux place caries of the vertebræ with bone-softening, alongside of true osteomalacia. The deformities of the spinal column in Pott's disease are distinguished from the rounded curvatures of osteomalacia by their angular shape, and by the ossifluent abscesses which often accompany them.

(6) *Cancer* of the vertebræ merits more attention. In certain diffuse forms of cancer, the symptomatic picture may be altogether like that of osteo-

malacia. (Volkmann.) But it is very rare for the diffusion of the neoplasm not to have been preceded by a carcinomatous tumor in some organ—the breast, the uterus, etc.—or circumscribed in some part of the skeleton.

I have so often, in the course of this article, indicated the differences between *rachitis* and osteomalacia, that it would be a useless repetition to recur to them here.

Professor Lücke, of Strasbourg, has recently proposed percussion of the bones as a means of diagnosis between caries and necrosis. It may be seen from Piorry's *Traité du plessimétrisme*, and from the monograph on softening of the bones by Souligoux, his pupil (1866), that the Professor of Clinical Medicine in Paris taught that all diseases of the bones—fractures, luxations, atrophy, hypertrophy, tumors, etc.—could be diagnosticated and marked out by means of mediate percussion. I refer the reader, for further particulars, to the writings of this author and his pupils, restricting myself to saying that Piorry assigns a *malacic sound*, dull, not ringing, to bones affected with the disease which we are studying. Happily there are other means besides percussion for diagnosticing diseases of the bones.

Prognosis and Course of Osteomalacia.—Always sad, says Volkmann, and all the more sad because death, which is almost always the end of this terrible malady, usually lingers long. In women, as we have seen, a first pregnancy may bring on the most serious developments of osteomalacia. But usually this is not the case, a first confinement awakening only moderate ischiatic and sacro-lumbar pains, which hardly lead to the suspicion of osteomalacia. Then, when the lying-in is over, there is a remission, even an apparently complete recovery. As the disease does not interfere with any function—neither menstruation, fecundation, nor gestation—the woman remains apt for conception. If new pregnancies occur, the disease returns with each, increasing in severity from pregnancy to pregnancy, and thus progressively reaching its height. The history of the *femme Supiot* is a classical example of this advancing course under the influence of the puerperal state. The cases in which, on the contrary, the disease ameliorates during a new pregnancy, are excessively rare; but they are undeniable. (Volkmann.) Here is an example: Winckel, the elder, had attended a woman affected with osteomalacia, and had employed the Cæsarean operation to deliver her in one confinement. In the course of another gestation this woman died. Winckel, the younger, found at the autopsy that death has been due to rupture of the uterus at the seat of the cicatrix left by the Cæsarean section, and also that the osteomalacia which had made this necessary had been entirely cured. All the bones which had been soft and extensible had returned to the normal state; the bones of the pelvis were even more massive and harder than usual. There were osteophytes in a number of places; and synostoses, the result of fractures, were found at the sacro-iliac synchondroses.¹ Therefore recovery is not impossible in the puerperal form. Nevertheless, we must not feel too hopeful when the process is seen to suspend its progress or even to retrograde. It is a perfidious retreat, from which it is the rule for the disease to return with increased intensity. Death ends the scene, less from the progress of the changes in the bone itself than from the disorders and functional disturbances which are its consequence: slow asphyxia, stoppage of the heart, bronchopneumonia, embolism, thrombosis, impossibility of taking food, diarrhœa, profuse sweats, etc., and the whole train of the malacic cachexia.

Treatment of Osteomalacia.—Therapeutics can do little in osteomalacia. We can only relieve the patient, and delay the fatal progress of the disease, by the following means:—

¹ Winckel, Monatschrift f. Geburtsh., Mai, 1864.

1. *Hygienic Measures*.—The patient should be placed in dry, warm, and well-ventilated quarters, and should be furnished with abundant and generous food, and all the comfort possible. This is easy to say, but less easy to do. When mastication and deglutition have become impossible or difficult, in consequence of softening of the jaws, the patients must be nourished through the œsophageal tube.

2. *Therapeutic Measures*.—Sulphurous and ferruginous baths have been recommended. But they cannot always be had, and the advice is illusory. All the drugs imaginable have been tried: antiscorbutic, antisyphilitic, antiphlogistic; turpentine, madder, cod-liver oil, iron, cinchona, etc. The phosphate of lime, in spite of the sarcasms of Boyer, is one of the most rational medicaments to employ in all forms of osteomalacia. Phosphoric acid seems also to merit a certain degree of confidence, if we may believe a communication by Prof. Busch, of Bonn.¹ This surgeon has made some experiments upon the action of phosphorus in diseases of the bones. There was no result in caries or rachitis, but, on the contrary, success in two cases of osteomalacia treated with phosphorus. Let us see what was the nature of this success:—

CASE I.—A woman, 30 years old, the disease beginning during her third gestation. In six months the pelvis alone was considerably deformed. Recovery in five months by the use of Wegner's pills, and rest in bed.

But it is confessed that the patient could not be well watched. Perhaps she never took the pills.

CASE II.—A woman, 50 years old, pains beginning in the right arm. At the end of nine months, marked cyphosis and lordosis, curvature of the clavicles, of the thorax, and of the femurs. The patient, lying down almost constantly, could walk only by leaning upon something, and by having the thighs in adduction. The pelvis showed characteristic alterations. At the end of seven months of treatment with phosphorus, she could walk with crutches, which she afterward abandoned, and then walked without support.

The deformities in these patients naturally persisted. Who can say that they will not have a relapse? Binz believes that the action of phosphorus ought to be attributed to a formative irritation, caused by increased oxidation of the tissues. This is why, he says, other agents which have the same relations to oxygen have been able to exert a happy influence; such are arsenious and pyrogallie acid. (Mass, Gies, Binz, Schultz.)

3. *Orthopædic Measures*.—When the disease is fully developed, and the stage of deformity has been reached, it is necessary to prescribe rest in bed in order to avoid fractures and bendings, to secure a suitable position, to place broken or curved limbs in splints appropriate to each case. Bonnet's splint is of great service to prevent fractures or to favor their reunion, to maintain the limbs in good position, and to permit the patient to attend to the necessities of nature without fearing a recrudescence of pain, or the production of fracture. Care must be taken to line the splint with cotton to prevent the formation of eschars.

In spite of all precautions, it will happen, especially toward the end, that the patients cannot longer remain in the large splint. Their wishes should be acceded to, and they should be allowed to assume any posture that they wish, however bizarre and absurd it may seem. They are better judges than we are of their sensations. At this stage the part of the surgeon yields to that of the sister of charity.

Volkmann sums up almost the whole of useful therapeutics in the advice to be given to women affected with puerperal osteomalacia, not to expose themselves to new pregnancies. This advice, and the uncertainties

¹ Niederrh. Gesellsch. f. Nat. und Heilk. zu Bonn, 16 Mai, 1881.

of the pharmacopœia, show clearly the impotence of art in this redoubtable and enigmatic malady.

OSTEITIS DEFORMANS OF PAGET; BENIGN HYPERTROPHIC OSTEOMALACIA.—Sir James Paget described, on the 14th of November, 1876,¹ under the name of *osteitis deformans*, a disease of the bones characterized by the following features. It commences in or after middle age; it is very slow in its course; it progresses for years without affecting the general health, determining no other troubles than those which result from alteration of the shape, volume, and direction of the diseased bones. Even when the cranium is enormously thickened (Fig. 795), and when all the bones are extremely altered in their structure, the intelligence remains intact.

Fig. 795.



Cranium of a man affected with osteitis deformans. Natural size. No. 395 A, of the Museum of the Royal College of Surgeons of London. (After Paget.)

The disease usually affects, in the first place, the long bones of the lower limbs and those of the cranium. It is usually symmetrical. The bones increase in size and soften. The affected portions of the skeleton which have to bear the weight of the body, are bent and deformed by the abnormal curvatures which they assume. (See Fig. 796 and Fig. 797.) The natural curves of the vertebral column increase, and from this results a considerable diminution of the height of the patient, which has already undergone considerable reduction as a result of the bending of the diaphyses of the tibiae and femora, and the lowering of the heads of the latter, the necks of which become almost horizontal. It is an important point that this softening, this loss of resistance, is accompanied neither by weakness of the limbs nor by fracture. The legs remain strong and in condition to support the weight of the body. They bend and do not break. In the first stages, or sometimes from the beginning to the end, the disease is accompanied by pains in the affected bones. They are taken to be those of rheumatism, of chronic periostitis, of syphilis, of gout, of neuralgia, etc. There is never fever, nor anything abnormal in the urine. There is no association with syphilis, or any other constitutional disease except cancer. For, in the first five

¹ On a form of Chronic Inflammation of the Bones, Osteitis deformans. (Medico-chir. Trans., vol. lx.) VOL. III.—55

cases of Paget, there were three in which cancer showed itself toward the end of life. Is this a simple coincidence? At any rate, Paget himself recognizes that this point demands examination. There are in the museums, at Guy's Hospital especially, specimens of symmetrical osteoid cancer of the iliac bones, with cancer of the vertebral column and of the cranium—specimens in which the walls of the latter show hypertrophy comparable to that of *osteitis deformans*. In the first case of Sir James Paget, there were cancerous nodules in the walls of the cranium. The bones of this first typical patient (see Figures 796, 797, and 798), were examined microscopically by Mr. Butlin. There was a peculiar inflammation, affecting, in the cranium, the whole thickness of the bone; in the long bones, chiefly the compact layer of the walls of the diaphysis, as well as that of their articular surfaces. It is probable that these changes were inflammatory from the beginning, because the softening was accompanied by thickening (see Fig. 798), by proliferations

Fig. 796.

Fig. 797.

Fig. 798.



Figures 796 and 797. Osteitis deformans, from photographs taken six months before the patient's death. (After Paget.) Notice the curvature of the lower limbs, and the arching of the back.

Fig. 798. Section of the upper end of the patient's right femur. Half natural size. (Museum of the Royal College of Surgeons, No. 385 B.)

of imperfectly formed bone, and by hyperemia. Mr. Butlin asks, Does the inflammation persist to the end; or, after having lasted a number of years, does it give place to the reparative processes of consecutive eburnation? It is not known. But it is known that the inflammatory nature of the disease is incontestable. The Haversian canals (see Fig. 799) are enlarged by

lacunar erosion, as they are in every inflammation of the bones. (Compare with Fig. 794, osteomalacia.) The marrow which they contain is remarkable for its richness in fibrillar cells, which indicates its tendency to stable organization. Chemical analysis made by Dr. Russel has been almost negative. In cases examined in future, it will be well to ascertain before decalcifying with acids (which Mr. Butlin failed to do), if the eroded edges of the Haversian canals are decalcified by the mere fact of the disease, as Rindfleisch has shown to be the case in malignant osteomalacia. This is a capital point. Since his first paper, Paget has added seven new cases to the five which he had previously published.¹

In 1881, Mr. Treves² published an account of a case of *osteitis deformans* in a woman, who had had twelve children and two miscarriages, and several of whose children had been affected with rachitis. This woman had manifested for a year the signs of the bone-disease, when she had her twelfth child, which had a grave form of rachitis and died at the age of three years and a half. I have not been able to procure two papers on this subject; that of Symonds³ and that of Ellinwood.⁴

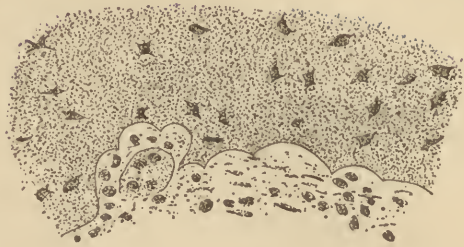
Prof. Ollier has seen several cases of this kind. He has mentioned to me, among others, the case of a woman affected with local osteomalacia (as he calls this affection) situated in the tibia, which he has had under treatment since 1866.

Diagnosis.—I think it useless to give the differential diagnosis from the ordinary forms of hyperostosis; there are so many differences between them and osteitis deformans that confusion is not possible when the latter is known. The preservation of the general health for years, the slow curvature of the long bones, which always remain capable of resisting the muscular contractions and of supporting the weight of the body, are the characteristics which distinguish osteitis deformans from all the known processes of hyperostosis, and there are, in fact, only two diseases with which it can be confounded: rachitis and osteomalacia.

Rachitis ought, in my opinion, to be entirely eliminated; since rachitis is a disease of the bones in the process of growth, and osteitis deformans is a disease of formed bone, and occurs in adults. A comparison can be made only with osteomalacia, which is also a disease of formed bone. Paget mentions, as a difference, that "in osteomalacia, the walls of the bone become exceedingly delicate and thinned, as in acute atrophy, and when they bend it is not with a regular curve, but with an elbow or angular fracture." He says, finally, that on account of the only characteristic which they have in common, that is to say, osteoporosis of the cranium, these three diseases—rachitis, osteomalacia, and osteitis deformans—are constantly confounded in museums.

Nature.—I shall not venture to take up the question of the nature of this disease, as the collected cases are not yet numerous enough, and as I have not had opportunity to examine personally bones thus affected. Yet the micro-

Fig. 799.



Histological preparation of one of the tibiae, to show the eroded outlines of the enlarged canals of Havers. Oc. 3, obj. 7. $\times 200$. (After Paget.)

¹ Additional cases of Osteitis Deformans (loc. cit., 1882).

² Trans. Path. Soc. London, 1881.

³ A case of osteitis deformans (Guy's Hosp. Rep. London, 1881).

⁴ Osteitis deformans (Western Lancet. San Francisco, 1883).

scopical examination made by Mr. Butlin, although incomplete, and the clinical history, seem to me to require that this affection should be put with true osteomalacia, as a benign and hypertrophic variety. It is, perhaps, to this form that a certain number of cases belong in which cures have been noted, with or without the aid of therapeutics. There is hyperostosis, because, the inflammation being moderated, the phenomena of repair on the part of the periosteum and the medullary canal are not obliterated by the concomitant phenomena of absorption, which occur in the canals of Havers. Curves occur in the long bones which support the weight of the body, because the medullization of the compact layers and the formation of new bone-tissue, which is also areolated and laminated, diminish the resistance of the bone. The bending does not go on to fracture, nor to angular curvature, because the conditions of resistance are not destroyed, but only lessened. In the grave form of osteomalacia, absorption is so rapid that it prevents or destroys all deposition of bone, and the bones reach the state of softness and want of consistence which I have already described. But, in one, as in the other, it is fundamentally the same process; here inevitably reaching its culmination more or less promptly; there remaining in its stage of commencement and manifesting itself in a more benign manner. This is why I propose to designate that which Sir James Paget has described under the name of *osteitis deformans*, by the name of *benign hypertrophic osteomalacia*.

PSEUDO-MALACIA OF INFLAMED BONES.—

It is rather a state of softness than of softening of the bones which I wish to designate by the name of pseudo-malacia of inflamed bones. By this I mean the bending, the curvature which is produced in the diaphysis of a long-bone during the stage of repair of an osteopathy, which has given rise to a large sequestrum and ultimately to the formation of an ensheathing shell. This shell, which is composed of young bone-tissue, and the neighboring parts, which are medullized by reactionary inflammation, have not much consistence, for lack of calcification of the abundant organic matter which enters into their composition. They are susceptible, consequently, of bending under the weight of the body when the patient walks too soon, or simply from the weight of the limb, if it gets crooked in the bed, if it is placed in a defective position. Muscular contraction may also contribute to these deformities; whence the importance of supporting the limbs in good splints. It is especially in the tibia and in the femur that deformities from this cause are seen after juxta-epiphyseal osteitis. It is reasonable to suppose that in a patient with early or delayed rachitis, this defect or this slowness of calcification of the periosteal or medullary osteogenic elements would occur with greater ease than in another subject. I am not aware that such cases

Fig. 800.



Section of a femur curved in consequence of inflammatory softening. (From the collection of M. Ollier.)

have been observed except in the period of growth. Here is a subject for investigation. I know nothing comparable to it in adults, except the delayed calcification of callus in fractures. The femur is sometimes seen to become curved when the patient, after a fracture of the shaft of the bone, is in too great a hurry to use it. Here, as in the cases to which I have alluded in the first place, the bone-tissue is defective rather in quality than in quantity; it still contains too many cartilaginous or fibrous elements, and it lacks density and cohesion.

Lobstein records two cases which were taken to be true osteomalacia, and which belong to the category of the morbid condition which I am now describing:—

Von der Haar speaks of a girl, about fifteen years old, who, after an exanthematous fever, had in the right arm and in the left leg an erysipelatous inflammation which terminated in abundant suppuration, necessitating a number of incisions, by means of which there was discovered not only enlargement of the bone, with caries, but also softening of the tibia and fibula, so that these bones bent when the leg was lifted by the heel, and curved like a bow when the limb was left to support its own weight. As a result of appropriate treatment, these bones recovered their former solidity; but it was noticed that they became deformed and thickened, and were at the same time shortened. "Here," says Lobstein, "is a well-marked case of acute osteomalacia, caused by metastasis one month after an exanthematous fever." The same author reports a second example of softening, observed in the femur of a boy, nine years old, who, excepting smallpox, which he had had at the age of seven years, had had no other disease except an acute fever with delirium, which degenerated into a slow fever. Forty days after the onset of this acute fever, there appeared a large tumor on the right thigh, which was at the same time bent and curved forward and outward. After free suppuration, and the exfoliation of a number of sequestra, his health was restored; his thigh-bone recovered its solidity, but remained enlarged and a little shortened.

Here, I would say—thanks to the investigations of M. Ollier in regard to juxta-epiphyseal osteitis and the pathological growth of bones—here are two well-marked cases of juxta-epiphyseal osteitis, the first following an exanthematous fever and causing an arrest of growth; the second coming on with an acute fever, terminating in abscess with elimination of a number of sequestra, accompanied by the formation of sub-periosteal layers of bone and medullization of the old bone, with curvature from contraction of the inner muscles of the thigh, and finally arrest of growth from excessive irritation (as in the first case) of the epiphyseal cartilages. There is not a surgeon who has not seen cases like these. It is to the same causes that I should refer fractures of the invaginating shells of sequestra, after the elimination or extraction of the latter, when the patient rises too soon, before eburnation of the bone-tissue has taken place, and when it is deprived of support by a splint or brace.

ATROPHY OF THE BONES; SENILE AND FATTY OSTEOPOROSIS.—I shall omit from this section certain arrests of development which have been improperly classed with atrophy; such as *congenital aplasia* affecting the whole skeleton (dwarfishness), or a part alone, as, for example, microdactylism, certain forms of club-hand, club-foot, etc.; such as *aplasia in young subjects*, from want of use of the limbs, from lesions of the cartilages of growth, from lesions of the joints or of the diaphyses which affect these cartilages secondarily; such as *neurotic aplasia*, in children affected with spinal paralysis; such as arrests of development following *resections* or *amputations*; such as aplasic malformations of the *cranium*, or of the *pelvis*, in young subjects who have premature or abnormal consolidation of the bones which compose these osseous cavities. All these questions, associated with the laws of physiological and pathological

growth, have been treated of by M. Ollier in connection with osteitis in general. As complementary information, I would refer to the very remarkable thesis of M. Gabriel Mondan,¹ prepared under the direction of M. Ollier.

I wish to speak here only of the atrophic phenomena which occur in completely formed bones, at a period when an individual has finished growing, and which are of a nature to diminish the solidity of the skeleton by absorption of the bone-substance without the bone becoming softened.

Two sorts of atrophy may be distinguished: One *eccentric* (called also internal atrophy by Curling); the other *concentric*. In *eccentric atrophy* neither the shape, nor the size, nor the external contour of the bone undergoes alteration. The marrow of the medullary canal and of the alveoli of the spongy tissue, as well as that of the Haversian canals, increases in quantity at the expense of the compact elements—of the lamellæ, of the trabeculæ, of the bone-tissue properly so called. It follows that the cortical layer becomes more and more thin; that the walls of the alveoli are absorbed, are thinned, until they gradually disappear. The union of a number of alveoli in the spongy tissue gives rise to more or less spacious medullary lacunæ. This process continuing, the medullized tissue of the cortical layer may disappear in great part from within outwards, and there will remain at the end only a bony envelope as thin as a sheet of paper. This eccentric atrophy, which occurs in old persons in variable degree under the sole influence of age, may be manifested in young subjects in certain pathological conditions. Senile atrophy has also received the name of senile osteomalacia; an improper term, since the bone is not softened. The quantity of bone-tissue diminishes, but that which is left preserves all its constituent elements, as Nélaton has proved. The expression senile osteoporosis is more exact and more in accord with histological revelations, which, according to Cornil and Ranvier, are the following: Senile osteoporosis is “a rarefaction of the bone-tissue by enlargement of the medullary spaces. In this case the friability of the bone is connected simply with its rarefaction. There is not here, as in true osteomalacia, softening of the bone by decalcification. This rarefaction of the bone is accompanied by important modifications of the medulla. These modifications present a certain analogy with those seen in true osteomalacia. They consist in the disappearance to a greater or less degree of the fat-cells, and in the formation of cells like those of the fetal marrow. Sometimes there is produced in the medullary spaces young connective tissue of new formation. The bones most frequently affected in this disease are the ribs and the vertebral column. The vertebral column becomes incurvated, fractures take place in the ribs on the slightest effort, and—which is quite a curious thing—they consolidate perfectly by the formation of cartilaginous callus which afterwards ossifies.”²

In patients who have not reached old age, rarefaction of the bone-tissue (fatty osteoporosis) is observed after chronic affections of the joints, and after prolonged immobilization of the limbs. In a Syme's amputation for fungous osteoarthritis of the calcaneo-cuboid joint spreading to other parts, which had condemned the patient to bed for two years, I found the uninflamed part of the calcaneum and of the other tarsal bones so atrophied that they crumbled between my fingers; the tibia was in the same condition—when cut, its enlarged alveoli poured out a material like oil.

Fatty osteoporosis is a rarefaction of the bone-tissue “characterized by an abundant production of adipose cells in the medullary spaces and in the

¹ Recherches expérimentales et cliniques sur les atrophies des membres dans les affections chirurgicales, système musculaire et système osseux. Lyon, 1882.

² Op. cit., p. 388.

Haversian canals. The bony trabeculae of the spongy tissue first become very thin, and end by disappearing. The bone is then reduced to a parchment-like shell pierced with numerous vascular openings."¹

There is no occasion to confound this state of fatty atrophy—which is produced still more quickly in the same conditions in old people—with fatty degeneration of the bones. The fatty condition of the bones in obese persons is not preceded or accompanied by rarefaction of the proper bone-tissue, or only to a slight degree. Lipoma of the bones is extremely rare, and its existence is even questioned by Virchow, who regards it as an exostosis containing large masses of fatty marrow. However this may be, there is present in such cases a circumscribed fatty tumor, and there are no bony partitions in its substance.

In *concentric atrophy*, the bone diminishes in size from without inwards, the transverse diameter, the thickness, diminishes. The long bones are not shortened, or only to a slight degree. The essential process of this sort of atrophy is little understood. It is probable that it consists in progressive and insensible medullization of the superficial layers of bone, and in the absolute cessation of all periosteal proliferation. Concentric atrophy does not exist alone, it is accompanied by eccentric atrophy, for the bones, the size of which is lessened, always have an enlarged medullary canal; and this double effect of the same process ends in rendering the bones more light. In adult animals, M. Mondan found the bone, after an amputation, affected with slight atrophic modifications. The total size of the bone "undergoes a reduction inappreciable by measurement, but one which nevertheless is obvious to the eye;" it becomes in fact "the normal reduction of the bone." (Ollier.) "It is reduced in all its dimensions, in its apophyses, in its ridges. At the same time its medullary canal is enlarged, and undergoes what Curling calls eccentric atrophy; but these phenomena are a long time in being manifested, and before they are clearly appreciable to the sight, weighing alone can enable one to decide the question."²

Atrophy of the bones is due to two principal etiological causes: *inactivity* and *senility*. As examples of the first category of cases, I will mention the atrophies of bone which are seen in old palsies, and in chronic inflammations and prolonged suppurations of the bones and joints, which, because of pain and the requirements of treatment, condemn the limbs for a long time to rest. I will cite also the diminution of capacity of the natural osseous cavities, the contents of which disappear or diminish; for example, the diminution of capacity of the orbit after wasting or enucleation of the eyeball; the diminution of capacity of the cotyloid cavity after an unreduced luxation of the hip, a diminution which may be rapidly carried so far that the head of the femur, which undergoes little concentric atrophy, can no longer be replaced. This is not a matter of retractility of the bone-tissue, as has been asserted.³

It is a general rule that portions of bone out of use undergo atrophy. Thus, as Curling⁴ has said, the bones, like the soft parts, fade away and waste when their activity is lessened or their function is suppressed. This author thinks that atrophy ought in some of these cases to be attributed to a diminution of the nervous influx,⁵ but usually to a lowering of the circulation. As an example, he cites eccentric atrophy—accompanied by absence or retardation of consolidation—of the fragments which, in fractures of the femur, do not keep the nutrient artery of this bone. He is mistaken in including osteo-

¹ Ibid., p. 389.

³ See Richet, *Anatomie Chirurgicale*.

² Mondan, *op. cit.*, p. 139.

⁴ Curling, *loc. cit.*

⁵ J. Wolf, anticipated as we see by Curling, has just published a work in which he makes atrophy of bone to depend upon an osseous tropho-neurosis.

malacia among the atrophies; these are pure and simple rarefactions of the bone, whilst in osteomalacia the decalcification appears to be primary, and to constitute the predominant phenomenon.

According to Curling, senile atrophy is also due to a defect of nutrition. It begins in the neck of the femur because this part of the skeleton is but slightly vascular. Senile atrophy resembles that of *mollities ossium*, he says, although to a less degree; and as there is usually a superabundance of phosphates in the bone-tissue, fractures are more frequently seen than softening. These propositions rest upon gross appearances. The two processes are absolutely different, as we have seen. All the osseous system of old persons is more or less affected with atrophy; but, when this physiological condition is quite accentuated, it becomes a morbid condition. Then it is that fractures occur with the greatest facility. Old persons have been seen to break their jaws while eating. The inferior maxilla, which is always reduced in size (concentric and eccentric atrophy), may be no more than a rim of bone. The scapulæ, the iliac bones, and the bones of the cranium, may be thinned to such a degree that parts of them may be placed directly under the microscope. (Volkmann.) They are sometimes even pierced with quite large openings.¹ Similar atrophies may be met with in patients who are cachectic although young. It is perhaps in this category that should be placed the perforated cranium (of a girl from 13 to 16 years old) which M. Charpy showed me. Aplasia and atrophy contribute to the same result in young cachectic persons.

Senile atrophy, whether premature or coming on at the time fixed by nature, predisposes, it will be understood, to fractures, among which that of the neck of the femur is the most common.

Fatty osteoporosis, brought about by inaction, also creates a predisposition to fracture, though less marked.

The prognosis of fractures in atrophic states of the bones is sufficiently unfavorable, because of the general condition of the patients; and it is made more gloomy by the danger of sudden death from fatty embolism. It is a matter of observation, also, that bones in fatty atrophy supply one of the most favorable soils for the evolution of septo-pyæmic processes (acute septic osteomyelitis), when, in a compound fracture, in an amputation, or in a resection, etc., the precepts of the antiseptic method have not been followed. These accidents, very happily, pertain somewhat to ancient history. The anatomico-physiological conditions of the vascular circulation and the absorbing power of the osseous medulla, and the increase of the latter, explain the rapidity of septic poisoning.

Treatment is disarmed in the presence of senile osteoporosis, as in the presence of an inflexible law of nature. It should be limited to improving the patient's food and hygienic surroundings, if this be necessary, especially when the atrophy is very pronounced. When fractures occur, they should be treated as those of normal bones, always remembering, in order to palliate them, the inconveniences of confinement to bed in old persons (pneumonia, fatty embolism, digestive disturbances, eschars).

In fatty osteoporosis caused by inaction, in non-senile patients, it may be hoped that good food and better hygienic conditions may renew the vitality of the tissues. After and during the employment of these general measures, recourse should be had, as soon as possible, to means of curing the disease which condemns the patient and the limb to inactivity; that is to say, curing the ankylosis, the osteitis, the arthritis, etc. In operative procedures it is important to remember the fragility of the bones, in order to avoid breaking them.

¹ See Feré, *Atrophie sénile des pariétaux*. (Progrès Méd., 1882.)

WASTING OF THE BONES.—I cannot omit speaking of a sort of atrophy which has received the name of “wasting of the bones.” It is caused by abnormal, persistent compression. A benign or malignant tumor, pressing against the bone, is the commonest agent in producing it. Its pressure, irritating the tissue of the bone, causes its insensible absorption by a process of medullization, analogous to that which is produced experimentally in animals by surrounding their bones with elastic bands or with a simple unoxidizable platinum wire. Further, there have been noted under these tumors rugosities on the surface of the bones, which have undergone losses of substance, wastings by compression. Sclerosis has also been observed, which may be accompanied by medullary ossifications capable of obliterating the central canal of the long bones. The whole thickness of the diaphyseal wall of these bones may be thus progressively wasted. The continuity of the bone may even be totally interrupted. For example, neoplasms of the dura mater have been seen to perforate the cranium, naso-pharyngeal polypi to penetrate into the cranial cavity by perforating its base by wasting, and aneurisms to perforate the sternum and the vertebrae. The pulsatile expansions of aneurisms and very vascular tumors determine more quickly these local atrophies by compression. Cancer, according to Volkmann, can sometimes only exercise a local atrophying effect by invading the connective tissues of the Haversian canals and of the medullary spaces. In order to have a true cancerous degeneration, it is necessary for the cancer to reach the bone-corpuscles or to proceed from them. The fact is that in cancerous persons the bones are sometimes very fragile, and that, in many cases, cancerous material has been found at the seat of fracture. In unreduced luxations and sub-luxations, the abnormal pressure of the bones, one upon the other, gives rise to the phenomena of wasting which sometimes lead to the formation of a movable or ankylosed false joint. In the joints, an abnormal position, with or without contracture, may finally bring about atrophy of the cartilages and of the portions of bone which are in contact, and afterward union of the latter.¹

I may remark, in a general way, that, in very extensive atrophy of the bones, of whatever sort it may be, the excess of phosphates in the economy—especially if the kidneys are acting inefficiently, as is often the case in diseases of the bones—may favor and explain the formation of abnormal calcifications in the tissues and in the organs, not to speak of renal and vesical calculi. (Scarpa, Ribes, Virchow, Volkmann).²

IDIOPATHIC FRAGILITY OF THE BONES.—The progress of pathological histology may perhaps some day erase this term from the nosology of the bones. Meanwhile, this name is given to a condition of the bones, still unknown as far as histology is concerned, which is characterized clinically by an extraordinary proneness to fracture. In the midst of perfect health, with bones absolutely normal in appearance, some persons break their limbs without apparent reason: in turning in bed, in making a sudden movement or a false step, or as the result of a trifling fall. It has been claimed that this predisposition appears to be congenital. It is probable that the bones in such cases have been affected by intra-uterine rachitis, or by rachitis coming on soon after birth. Is this predisposition hereditary? Volkmann says that it is, and adds that it increases in intensity from generation to generation. It has been said that the female sex is most apt to exhibit this fragility, especially

¹ See B. Teissier (de Lyon), Thèse.

² Dr. Samuel Gee has published in St. Bartholomew's Hospital Reports, vol. xvii., an article, entitled: On osteal or periosteal cachexia. The cachexia, he says, in place of provoking atrophy, causes tumefaction of the bones. The facts are not clear; for there is a question of rachitis, of osteomalacia, and of syphilis.

in old age. Certainly the skeletons of women have normally less power of resistance than those of men. One ought to be very careful not to confound in old age, especially in women, the fragility of the bones which results from senility—which is sometimes very precocious in women who have had many children, and an unhappy life, full of all sorts of privations—not to confound this, I say, with essential fragility. In very young patients one should rather think of rachitis, and not speak of idiopathic fragility unless rachitis is absolutely absent.

With these reservations, I will mention without comment that cases are recorded of unfortunate possessors of essentially fragile skeletons, who, after having sustained an incalculable number of fractures, became smaller and smaller, in consequence of the over-riding of fragments. At the Middlesex Hospital,¹ there was a girl fourteen years old, otherwise perfectly well, who had had thirty-one fractures since the age of three years; among other bones, she had broken one tibia nine times. What distinguishes these fractures from other conditions of fragility of the bones, is the ease and rapidity with which they are repaired.

What is the real cause of essential fragility of the bones? It is evidently a disturbance of nutrition or of composition; but which? Only vain hypotheses can be suggested, as long as no autopsy has been made, and no examination of the bones, either microscopical or chemical. The ancients often noted fragility of the bones as a consequence of scurvy. From the oldest times syphilis has been accused of rendering the bones friable, especially when the treatment involved salivation. The fragility of the bones in scurvy and syphilis is not an idiopathic fragility, since it is consecutive to the rarefying osteitis caused by those diseases. In syphilis the bone may also be fragile because it is the seat of a gumma. There have even been examples of this in children, as in Behrend's case, in which there were spontaneous fractures of the humerus and femur in a child eleven months old, with congenital syphilis.² I have already said what I think of fragility of the bones in cancer. In the case of all neoplasms complicated with fracture, whether spontaneous or caused by trifling traumatism, there can be no question of essential fragility; the bone breaks easily, either because it is invaded and destroyed by the tumor, or because the pressure of the latter has diminished its volume, its thickness, and its power of resistance by wasting.³

Idiopathic fragility naturally remains unrecognized as long as the fractures are not multiplied. It is distinguished from osteomalacia by the absence of acute pains and of softness of the bones. The patients who are affected with it are otherwise perfectly healthy.

Treatment can be addressed only to the fractures. It is necessary to guard against vicious union, which alone is the cause of deformity in this singular disease, or tendency, of the bones. Some day, perhaps, the progress of histo-chemistry will enable us to attribute it to a cause over which therapeutics may have some control. At present we are limited to the common prescriptions of food and hygiene.

SYPHILIS OF THE BONES.—Syphilis of the bones might properly be described in connection with the preceding affections, but has already been sufficiently considered in a previous volume.⁴

¹ London Med. Gazette, vol. xii., 1853.

³ See page 873, *supra*.

² Berlin. klin. Woch., No. 30, 1882.

⁴ See Vol. II. pp. 375, 433, 457, *supra*.

TUMORS OF THE BONES.

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AMONG surgical affections, tumors of the bones are quite common lesions, and the same neoplasms are met with in bone-tissue as in the soft parts. It is hard to classify these tumors satisfactorily. Pathological anatomy, taking into consideration the elements which compose them, their form, and their disposition, furnishes many distinctive signs which are of great importance; but there are certain problems of which it cannot yet be expected to furnish the sole solution.

The grand and eminently practical division of tumors into benign and malignant, should then be maintained for the neoplasms of bone. Indeed, whatever may be the progress realized in the domain of pathological histology, it is important not to lose sight of the fact that it cannot at the present time furnish by itself a positive indication of the course, evolution, and prognosis of a tumor. Clinical surgery can see in it only a new means of investigation, and, under the present order of things, is most often obliged to draw its materials for judgment from signs long familiar.

Yet if we seek to class tumors of the bones in the ranks of benignity or of malignity, we shall not be long in discovering that, as is also the case in every general classification of tumors, a variety which is usually benign may, under some more or less well-defined circumstances, become malignant. The name of the tumor alone—myxoma, chondroma, sarcoma, for example—cannot furnish sufficiently exact indications in regard to its evolution. Thus a chondroma of the phalanges, or of the metacarpal bones, may for long years, or even during the whole life, cause only functional disturbances, while a chondroma of the lower end of the femur, or of the upper end of the humerus, may rapidly increase in size and behave like a malignant tumor, infecting the whole system, and often becoming generalized. I could multiply illustrations of this sort in regard to sarcoma, as it occupies the gums, the edges of the alveoli, or the ends of the long bones; but I shall have occasion to return to facts of this nature. What it is important to know is, that tumors of the bones behave differently, and have a different prognosis, according to the age of the patient and his hereditary condition, and according to the seat of the lesion and the particular bone affected.

Considering only pathological anatomy, tumors of the bones include: exostoses, fibromata, myxomata, lipomata, chondromata, osteoid tumors,

myeloplaxic and medullary tumors, spindle-celled sarcomata, epitheliomata, encephaloid and other carcinomata, lymphadenomata, simple cysts, hydatid cysts, and vascular or pulsatile tumors. I shall describe these different varieties separately; their study will thus be more simple and more classical. I cannot, indeed, for reasons already given, adopt a classification according to the degree of benignity. Yet I would remark here that, from a clinical point of view, exostoses, lipomata—which are so rare that their existence is questioned—cysts, and pulsatile tumors—sometimes called aneurisms of the bones, and also very rare—belong to the category of benign tumors. Other tumors which are often benign, are sometimes malignant: fibromata, myxomata, chondromata; and the same is true of certain neoplasms called myeloplaxic and medullary tumors, grouped under the name of myeloid growths. Finally, the really malignant tumors are: sarcomata, epitheliomata, carcinomata, and osteoid tumors.

EXOSTOSES.

By the name exostosis, is meant an abnormal and circumscribed production of bone-tissue, on the surface or in the interior of a bone. (Duplay.) In the latter situation, the masses protruding into the interior of the bone have often been designated by the name of *enostoses*; but usually the name exostosis is employed in the general sense which I have attributed to it in the definition.

Before entering upon the study of exostoses, it will be well to differentiate them first from other abnormal productions of bone.

In the first place, when a long bone is more or less uniformly increased in size in its whole length, or in a considerable part of its extent, by the formation of new layers of bone, the name *hyperostosis* is given to the lesion. On the other hand, in the neighborhood of old bone-lesions, or even sometimes of lesions of the soft parts, as in old ulcers of the leg, masses of bone, to which the name *osteophytes* have been given, are seen to form. In a word, in order to have exostosis, it is necessary: 1. To really have a tumor.¹ 2. This must be made up of true bone-tissue (this is why odontoma is entirely distinct from exostosis). 3. The tumor must have its starting-point in one of the constituent elements of bone; which enables us to eliminate certain neoplasms called *parosteitic osteomata* by Virchow. This author has designated by the name *apophyseal exostoses*, exostoses beginning as ossifications in the portions of tendons attached to the bone; the production of bone is afterwards prolonged into the tendons in the shape of long needles. In some cases, from twenty-five to fifty such prolongations have been found upon the skeleton.

History.—The older authors, and more lately J. L. Petit, Boyer, and Sir Astley Cooper, confounded under this title different tumors, grouping under the same designation both sarcomata and carcinomata. More recently the different varieties of exostosis have been confounded. The first precise account of the exostoses of development, appeared in the thesis of Dr. Soulier, in 1864,² and in regard to this variety, the thesis of Dr. Labarthe³ and the clinical lectures of Professor Gosselin⁴ may be consulted with advantage.

Pathological Anatomy.—Exostoses were formerly divided into *eburnated exostoses* and *spongy exostoses*. Cornil and Ranvier divide them, like the osteomata into: (1) *eburnated exostoses*, (2) *compact exostoses*, (3) *spongy exostoses*.

¹ Heydenreich, Dict. Encycl, etc.

² Du parallélisme parfait entre le développement du squelette et celui de certaines exostoses (Thèse.) Paris, 1864.

³ Thèse de Paris, 1871.

⁴ Clinique Chirurgicale de l'Hôpital de la Charité, 3e édition. Paris, 1878.

(1) *Eburnated Exostoses*.—The lamellæ of bone are parallel to the surface of the tumor. In the midst of the lamellæ are seen bone-corpuscles, the canaliculi of which are almost all directed toward the periphery. No vessels can be distinguished in them. (Virchow, Cornil and Ranvier.)

(2) *Compact Exostoses*.—The bone-tissue recalls that of the diaphyses of the long bones. The bone-substance is arranged in concentric lamellæ surrounding the vascular canals. The canals of Havers have a less regular direction than in the shafts of the long bones. The bone-tissue may be whiter, the osteoplasts more regular.

(3) *Spongy Exostoses*.—Their structure is that of the spongy or areolar tissue of the bones. The contained marrow is embryonic, gelatinous, fibrous, or fatty. Exostoses which are at first spongy may be modified, and may become compact, or conversely.

If the seat of the exostoses be considered, and not their structure, they may be again divided, according to Cornil and Ranvier, into (1) *epiphyseal exostoses*, projecting on the surface of the bone like supplemental epiphyses; (2) *parenchymatous exostoses*, developed in the thickness of the bone; and (3) *enostoses*, situated in the interior of the bone.

(1) *Epiphyseal Exostoses* (Cornil and Ranvier).—This form of exostosis is met with on all the bones. It has been seen on the bones of the cranium, and in this case it is generally associated with syphilis. It has also been met with on the short bones. I saw in a young man of seventeen, in the Croix-Rousse Hospital, two symmetrical exostoses, situated on the internal surface of the calcaneum. These exostoses are also seen on the phalanges; witness the sub-ungual exostoses of the great toe, and of the phalanges of the fingers. The new tissue and the old are easy to recognize in a section. The new tissue is applied over the lamellar systems of the old bone, without their destruction. These exostoses are generally developed under the periosteum in consequence of a proliferation of the sub-periosteal medulla; the direction of the lamellæ, being determined by that of the osteo-periosteal vessels, is perpendicular to the surface of the bone.

(2) *Parenchymatous Exostoses*.—This form of exostosis has its birth in the thickness of the bones. In consequence of a rarefying osteitis, there occurs a loss of substance, filled up by inflammatory medullary tissue, which becomes the starting-point of an exuberant production of bone. (Cornil and Ranvier.)

(3) *Enostoses*.—These tumors, which are usually formed of compact tissue, more or less fill the central canal of the bone. Sometimes they form simple nodules; sometimes they are diffuse. They are not perceptible on the outside, except as they have thrust out the bone which surrounds them, and which incloses them with a bony capsule which may afterwards be perforated. Certain authors have designated as *enostoses* tumors which protrude into a cavity like that of the cranium. I believe that the name ought to be reserved for growths which are inclosed within bone, and not applied to such as protrude from it. In some cases enostoses may be, at the same time, parenchymatous exostoses.

If we regard the shape of exostoses, they are seen to present numerous varieties. Some have the shape of an appendix, a spine; others are pedunculated, or sessile; and, finally, there are some which by their extent resemble hyperostoses. The size of an exostosis may in some cases equal that of an adult's fist. These tumors are sometimes propagated from one bone to another. They have been seen to fill up the space occupied by a suture, or by an interosseous ligament. They often respect the vascular canals. In chemical composition, the exostoses contain more phosphates and less carbonates than normal bone. They have been observed on all the bones of the skeleton, but more frequently on the superficial bones; perhaps those of the

deeper bones are harder to recognize. They are found preferably, however, on the long bones of the limbs, and on the bones of the skull and face.

In a patient in the wards of the Hôtel-Dieu of Lyons, I saw some years ago multiple exostoses. All the extremities of the long bones were the seat of hard tumors, of exostoses, some of which were the size of a fist. The patient, who was forty years old, was not incommoded by the tumors. These variously shaped osseous masses occupied the ends of the long bones—to be more exact, the juxta-epiphyseal portions—a point upon which Broca and Soulier have dwelt. They were also, by their greater development at certain juxta-epiphyseal portions, a new clinical demonstration of the laws formulated by Professor Ollier¹ in regard to the growth of the long bones.

Etiology of Exostoses.—Sometimes, in consequence of a contusion, of a blow, there is developed on the surface of a bone a slow inflammatory process ending in the formation of an exostosis. Under other circumstances, in consequence of an inflammation of neighboring parts, as in certain cases of rebellious ulcer, masses of bone are formed, varying from an osteophyte to an exostosis. Syphilis often causes the production of exostoses; and generally on the bones of the skull.

These three classes comprise all the forms of exostosis which can be called *symptomatic*.

By the side of these *symptomatic exostoses*, Soulier classes the *idiopathic exostoses*, which he divides into two categories: *Osteogenic* exostoses, or exostoses of development, and *autogenic*. The latter are those in which none of the causes which I have mentioned are recognized. They have become more and more rare in proportion as a more rigorous investigation of the history and antecedents of the patients has been made. Heydenreich does not hesitate to exclude them. I believe that we may properly follow him, and retain in our classification:—

Idiopathic exostoses,	Osteogenic, or of development.	
Symptomatic exostoses	{	From a local cause, { Traumatism.
		From a general cause, { Neighboring inflammation.
		Syphilis.

OSTEOGENIC EXOSTOSES, OR EXOSTOSES OF DEVELOPMENT.—It is, as I have said, only since the thesis of M. Soulier that a clear idea has been formed of exostoses coming on during growth, and keeping pace with the development of the skeleton. These exostoses have sometimes been called *epiphyseal exostoses*.² I shall reject this denomination, as it suggests the inference that these bone-tumors are developed habitually on the epiphyses—which is not the case—and as on the other hand it might cause them to be confounded with the exostoses which I have called epiphyseal, following Cornil and Ranvier. Under the name *cartilaginous periosteal exostoses*, Sir Astley Cooper did not have in view exostoses of development alone; indeed, he gives this name to a bone-tumor occurring in a patient fifty years old.

Osteogenic exostoses arise in the portion of the diaphysis in which the bone increases in length, in the part of the bone called juxta-epiphyseal. They have, indeed, as Broca and Ollier have shown, this seat in common with inflammatory and neoplastic lesions in young subjects. The name epiphyseal exostosis should then be supplanted by the name juxta-epiphyseal exostosis. Under the influence of any form of irritation, an excessive activity of the

¹ *Traité de la Régénération des Os*. Multiple exostoses are not rare; and under certain circumstances, as in the case of the patient referred to, it would seem as if the subjects were under the influence of a true osteogenic diathesis.

² *Compendium de Chirurgie*.

connecting cartilage may, at some point of its circumference, give birth to an exostosis.

Seat, Size, Shape, etc.—These exostoses occupy the ends of the long bones, and especially the lower extremity of the femur (principally on the internal surface, above the condyle), the upper end of the humerus, the tibia, etc. They are met with on the pelvis, the scapula, the junction of the sphenoid and the basilar portion of the occipital bone. Usually these exostoses are small—the size of a cherry. Still, a number of larger ones have been reported, one of which attained the size of the head of an adult. According to Dr. Soulier, they are sometimes wart-like, sometimes tuberculated, sometimes in the form of an apophysis, or actually coracoid. They are often multiple, and may or may not be symmetrical. Symmetry is of real importance in the diagnosis of this variety. The course of exostoses of development is slow; they follow the development of the skeleton, and especially that of the bony extremity upon which they are situated.

Structure.—At an early period osteogenic exostoses are composed of, (1) a layer of periosteum; (2) a layer of cartilage; (3) bone-tissue apparently analogous to that of the bone itself. At a later period the cartilage has generally disappeared, the bone-tissue has become spongy in the centre, and sometimes it is hollowed out by a medullary cavity communicating with the medullary canal of the bone.

When the exostosis of development is situated on the diaphysis of the bone, it is the rule to see it recede from the articular extremity as the bone increases in length. This fact is sometimes noticed by the patient himself; it is more manifest as the exostosis has made its appearance at a period more remote from that of the cessation of growth. The same occurrence is not noticed when the exostosis is upon the epiphysis. Friction sometimes occasions the production, on the surface of these exostoses, of adventitious serous bursæ, which sometimes communicate with the synovial membranes of the neighboring joints.

Etiology.—The etiology of these exostoses is little understood. It seems that inheritance plays a certain part in some cases. Traumatism has been supposed to be concerned in their production, and pressure, fatigue, rheumatic periostitis (Virchow), and rachitis; but none of these causes is absolutely demonstrated. They are usually developed from the 11th to the 30th year.

Symptoms.—The beginning of these exostoses is usually insidious, and they are generally discovered by accident. Sometimes, however, slight pain or interference with certain movements, has been noticed. On exploration there is found a rounded tumor, generally a little mammillated, and well circumscribed. It is of a peculiar consistence, and of bony hardness. The adherence to the bone is absolute. On the contrary, the skin and the superficial tissues move freely, and have undergone no change. Painlessness is almost always complete. In their development, exostoses act upon the surrounding organs and may give rise to certain accidents. Thus there have been observed acute and chronic hygromata of the newly-formed serous bursæ which sometimes cover the tumors more or less completely. Compression of the neighboring nerves sometimes gives rise to extremely violent irradiating pains. Coote¹ operated upon an exostosis of the transverse process of the seventh cervical vertebra, in a patient 26 years old. The tumor had caused numbness, and pains in the hand, fingers, arm, and shoulder of the same side. I saw, in a woman 22 years old, a little exostosis the size of a pea, situated on the external surface and almost at the median part of the eighth right rib. This tumor was painful on being touched, and was ac-

¹ Union médicale, 1861.

accompanied by intercostal neuralgia. I practised ablation, and the pain disappeared entirely. Vessels like the subclavian artery, the femoral, or the popliteal, have undergone consecutive ulceration. The muscles are sometimes the seat of spasms and of contractures. Finally, certain exostoses determine complications on account of the particular region in which they are found. Their presence in the cavity of the pelvis is in some cases an obstacle to labor. An exostosis has been known to perforate the bladder, and to lead to the belief that a calculus was present. These tumors never return after removal.

Diagnosis.—The age, the situation, the peculiar hardness, the exact limitation, and the profound immobility, are the signs which establish the diagnosis. I shall have to return to this point in studying other bone-tumors.

SYMPTOMATIC EXOSTOSES.—I shall have but little to say about the varieties of symptomatic exostoses. They are usually eburnated. As to the early symptoms, they will vary according to the cause which has given rise to the tumor. The history, the osteocopic pains of syphilis, will play an important part in the diagnosis of the cause. When once the exostosis has been formed, its signs will be the same as those of osteogenic exostoses.

Treatment of Exostoses.—Medical treatment is applicable only to exostoses of syphilitic origin, and, even with them, often leads to but incomplete success. Vigo's mercurial plaster, and the iodide of potassium internally, constitute the basis of the treatment. Recourse must be had also, sometimes, to the mixed treatment. John Hunter formerly recommended phosphoric acid internally; but this agent has been abandoned like others of the same kind. Recourse must therefore be had to surgical treatment, but I must say at once that, because of the dangers which may attend its employment, only those exostoses should be attacked which cause interference with the functions of an organ, or complications sufficient to authorize intervention. In cases in which an operation is contra-indicated, we should confine ourselves to advising the avoidance of fatigue and knocks, and to affording protection of the diseased part, either by an apparatus or by the application of layers of wadding.

(1) *Ablation.*—The tissues over the exostosis are to be incised, and, when this is exposed, its base is to be attacked either with a saw, with a chisel, or with a gouge and mallet. If the exostosis is voluminous, it may be broken into quadrilateral fragments, by saw-cuts crossing each other at right angles. Twice I have practised ablation of exostoses of the lower end of the femur, which were coracoid in shape, and which interfered with walking. No ill consequences followed, and there was no return, as I was able to assure myself a year and two years afterwards.

(2) *Resection.*—This consists in ablation of the portion of bone upon which the exostosis is situated. This operation is especially applicable to the bones of the face.

(3) *Denudation.*—Delpech, of Montpellier, sought to provoke necrosis by laying bare an exostosis, either solely by means of the contact of the air, or by combining with this cauterizations. These methods are abandoned, and with good reason.

(4) For *pedunculated exostoses*, Follin has advised to break the pedicle without previous incision of the skin, preventing its consolidation by frequent motion, and afterwards to extract the fragment of bone which is then attached only to the soft parts. In a patient fifteen years old, I broke off a coracoid exostosis of the lower end of the femur in this way. After some days of immobilization, I was careful to move the fragment every day, so that union did not occur, and, the functional pain which had made inter-

vention necessary having disappeared, it was not necessary to have recourse to ablation of the fragment of bone, which was engrafted in the midst of the neighboring tissues. The danger of these different methods is in many cases the occurrence of consecutive osteomyelitis, but the employment of the antiseptic method has considerably modified the prognosis of these operations. In certain cases palliative procedures have been employed. Ledentu,¹ in a patient who had an exostosis of the femur, practised subcutaneous section of the vastus externus, and this operation put an end to a violent pain which was accompanied by contracture.

FIBROMATA OF THE BONES.

Fibromata, or fibrous tumors, of the bones are very rare, and many of them have been confounded with sarcomata. These tumors are made up anatomically of fasciculated fibrous tissue. They may be divided, according to their point of departure, into *periosteal* and *central*, according as they start in the periosteum or in the medullary tissue. The latter are by far the rarer.

Periosteal fibromata are seen on the bones of the face and of the cranium. Naso-pharyngeal polypi belong to this variety. Some of the tumors formerly grouped under the name of epulis were fibromata. Volkmann says that he has seen them upon the pelvis and upon the ribs. In regard to fibrous tumors of the pelvis, I will mention a peculiar variety of tumor of the pelvic cavity, and especially of the wall of the abdomen, of which I formerly saw several examples in the service of Professor Ollier, and for which I have thrice had occasion to practise ablation in my own service. These tumors, mentioned for the first time by Nélaton, are attached to the crest of the ilium, or to some point of the pelvic rim, by a longer or shorter pedicle coming from the periosteum. They are seen most frequently in women. They have no relation to the bone, or rather to the periosteum, except their starting-point, and should not be included in a description of fibromata of the bones.

Central fibromata have been described by Paget in the inferior maxilla, the walls of which they push apart until they end by perforating them, and thus come to protrude on the outside. They have been rarely observed in the epiphyses of the large long bones, in the phalanges, and in the vertebrae.

Fibromata often undergo certain transformations. They become calcified, rarely are they ossified, sometimes they undergo fatty degeneration, or become cystic. In some cases they exhibit great vascularity. Their possible transformation into sarcomata is still doubtful, although admitted by G. Weber and Ed. Schwartz.² At any rate, it is well not to irritate such neoplasms; and if, from the anatomical point of view, the transition between sarcoma and fibroma is already only in some sort a question of degree, it must not be lost sight of that from the clinical point of view every neoplasm is a step taken toward a more serious new formation.

These tumors are formed by an agglomeration of hard lobules, constituted individually of a tangle of concentric fibrils. (Cornil and Ranvier.) They always remain well separated from the neighboring tissues. They are seen most frequently in youth and adolescence. Their growth is more or less rapid, and they may attain a very large size. It is to be noticed that certain varieties of these tumors, those known under the name of naso-pharyngeal *polypi*, are an exception to this rule; and that the majority of surgeons now admit,

¹ Revue Mensuelle de Médecine et de Chirurgie, 1879.

² Ostéosarcomes des Membres. Paris, 1880.

with MM. Gosselin and Legouest, that they undergo a stage of arrest and even of retrogression, at the age of about twenty-five years.

These are benign tumors, and usually do not recur after complete ablation, never implicating the lymphatic glands, and not becoming generalized, but being susceptible of undergoing certain transformations. Thus, in a young patient operated upon a number of times by M. Ollier, according to his method, for a fibrous naso-pharyngeal polypus, the tumor, after a number of recurrences, underwent a telangiectatic, aneurismal transformation. On ausculting the corresponding cheek, a strong blowing sound was perceived. These neoplasms are grave only from their size, and from the symptoms which they determine on account of the regions in which they are found. (These symptoms are treated of in studying naso-pharyngeal polypi.¹)

The only rational treatment of bone-fibromata is extirpation.

MYXOMATA OF THE BONES.

Myxomata of the bones are very rare, and often the myxomatous tissue exists only in mixed tumors, especially in certain myxo-chondromata and myxo-sarcomata. Volkmann admits that myxomata of bone-tissue arise in the centres of the bones. Cornil and Ranvier consider them as periosteal, and as capable of bringing about absorption of the bone at their point of implantation, and thus of penetrating to the centre of the medullary canal. According to these authors, it is easy to confound this neoplastic mucous tissue with the gelatinous-looking medulla of the bones of cachectic patients. Pure myxoma of the bones is a soft tumor, easily broken up. It presents nodosities, composed of several lobes, and of trabeculae belonging to the pre-existing tissue. The color is clear gray, whitish, or pink, and sometimes the gelatinous appearance is very marked. Virchow, who considers these tumors as starting from the medulla, says that they are for a time enveloped in a shell of bone, which afterward disappears. They are most frequently met with in the maxillae. In such cases the growths are often mixed neoplasms, myxomatous chondromata. This was the case in a young man upon whom, in my service at the Croix-Rousse hospital, I practised resection of the right upper jaw, and found a chondroma the whole centre of which was mucous or colloid. The diagnosis of myxoma from chondroma and sarcoma is almost impossible in many cases. The absence of cutaneous ulceration and of glandular invasion, and the course of the affection, furnish, however, valuable diagnostic signs. Myxomata of the bones are benign tumors, which do not become generalized; but they have a great tendency to local recurrence.

LIPOMATA OF THE BONES.

There have been recorded a single case of lipoma in the femur, observed by Cornil and Ranvier, and two cases in the superior maxilla (Viard and Triquet). Upon these observations rests the belief in the existence of this variety of neoplasm. According to Virchow, these tumors are only exostoses containing a large quantity of fatty marrow.

¹ See Vol. IV. *infra*.

CHONDROMATA OF THE BONES.

Chondromata are met with much oftener in bone-tissue than in any other structure. By the name of chondroma are designated tumors made up of more or less abnormal cartilaginous tissue. (Lücke.) It is proper to separate at once from chondromata certain cartilaginous productions which are formed only on pre-existing cartilages, and to which are given the name of *enchondroses*. Chondroma, properly so called, is never developed at the expense of pre-existing cartilages. (Cornil and Ranvier.)

History.—Chondromata were first studied by Cruveilhier,¹ and afterward by Müller, in 1838. The works of Vogel, Lebert, Fichte, Paget, Virchow, and Dolbeau, have completed the study of these tumors. In more recent times I would mention the thesis of Walsdorf,² and that of A. Aubert.³

Pathological Anatomy.—The varieties of bone-chondromata exhibit the structure of the different varieties of cartilage described in man, and besides, there are sometimes found in them anastomosing cells, forming a tissue like that of the cephalic cartilage of cephalopods. Dr. Bonnet writes as follows on this subject:⁴—

Stellate cells are often present in considerable numbers. It is not, indeed, frequent to find them buried in a fundamentally hyaline substance; but the true cartilaginous cells are themselves placed in such variable intercellular substances (hyaline, fibrillary, elastic, mucous), according to the different parts of a single neoplasm under observation, that it is permissible to consider the two forms, stellate and encapsulated, as almost equivalent. These two forms, in enchondroma, play the same part, and replace each other with the greatest ease. Besides, they are not the only forms seen in this kind of tumor. In it may be observed the indifferent embryonic cell, the stellate cell, the fibro-plastic body on the one hand; and, on the other, the whole series of cartilaginous cells, and that in one and the same enchondromatous production. At its appearance, the cartilage has the embryonic form; at a later period, a hyaline intercellular substance, soft or hard, is secreted between the cells; these increase in size, assuming different shapes, angular or discoid; this is foetal cartilage. It is only in the adult stage of the cartilage that the fundamental substance is condensed in such a manner as to form a sort of wall with double contour, or capsule, which contains the true cartilaginous cell. Less well-defined forms than the encapsulated may be seen in fibrous and elastic cartilages. M. Ranvier has studied these forms in the cartilaginous tendons of birds, etc. The cartilaginous cells appear as rounded, or rather cylindrical, cellular bodies, arranged in rows between the parallel tendinous bundles, which may and should be considered as the intercellular substance of these bastard cartilages.

All these appearances under which the cell of normal cartilage may be seen, may be met with in the cellular element of enchondromatous tumors. An enchondroma is usually divided into lobules, which are separated by connective tissue. At the edges of the lobules and of the connective tissue, there are often seen embryonic elements, at the expense of which the formation of cartilage takes place. Among the cells near the connective-tissue bundles, a certain number are fusiform; further in toward the centre of the lobules, they are surrounded by a very delicate rudimentary capsule. They are clear, rounded, smaller than the capsules of adult cartilage, and embedded in a fibrillar or soft substance. Finally, the stellate form is very common; but the cartilaginous cells must not be confounded with the cells of myxomatous points which are still much more frequent. (Bonnet.) All those varieties

¹ Anatomie Pathologique du Corps Humain, tome ii. 34e livraison, pl. 4 et 5. Paris, 1828; Traité d'Anatomie Pathologique, tome iii. p. 779, et tome v. p. 106.

² Le chondrome malin. Paris, 1878.

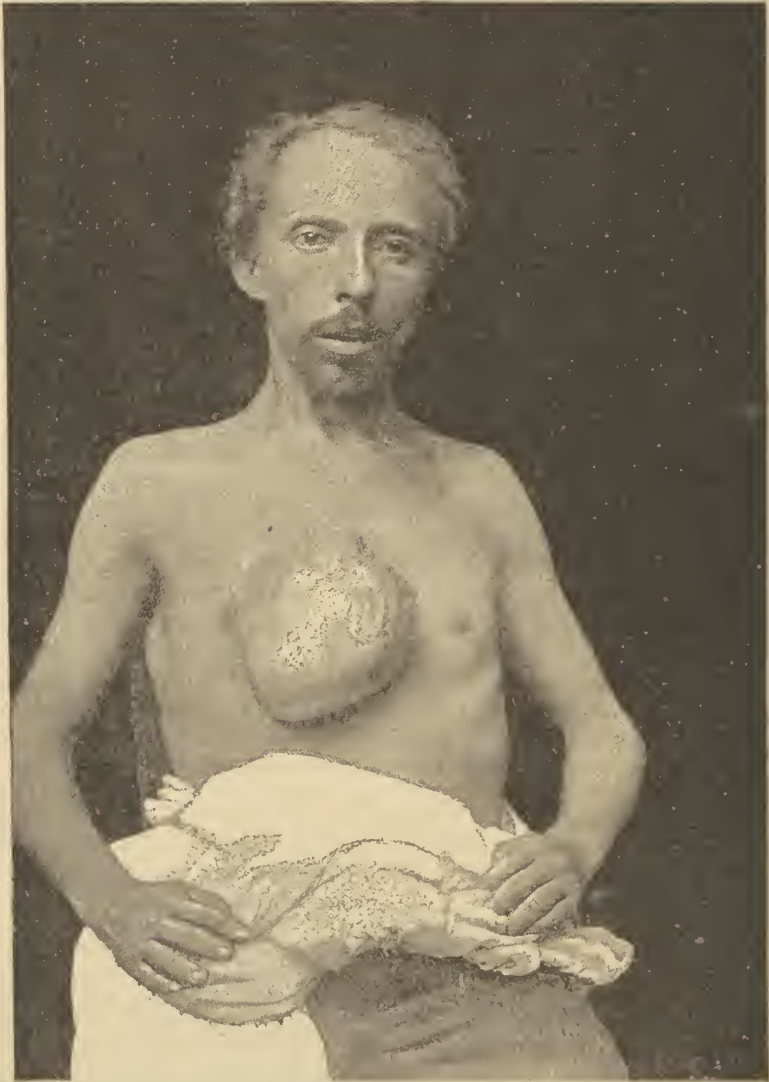
³ Thèse de Lyon, 1882.

⁴ Thèse de Lyon, 1882.

to which have been given the names of hyaline chondromata, chondro-sarcomata (Virchow), chondro-fibromata, ossifying chondromata, and chondromata with ramifying cells, may be met with in chondromata of the bones, but usually there is a combination of different varieties.

Chondromata have been divided into perichondromata and enchondromata, according as they are developed on the exterior or in the interior of the bone. Nevertheless, the term enchondroma is often used in a general sense. Chondromata are usually seen on the small long bones of the hand, and more

Fig. 801



Cystic chondroma, with calcified nodules, situated on the anterior surface of the sternum, and encroaching on the corresponding costal cartilages (Croix-Rousse Hospital, service of M. Poncet.)

especially on the phalanges. They are very rare on the cranium. According to Dolbeau, the middle finger is more frequently affected than the other fingers. In the other bones, these tumors are developed preferably at the ends, in the juxta-epiphyseal portions. Chondromata are generally multiple.

Schuh mentions the case of a girl, twelve years old, who had chondromata on all the bones of the skeleton except those of the cranium and vertebral column. They are circumscribed or diffuse; but the latter form is rare. There are, however, often found small isolated nodules in the neighborhood of the large tumors.

Shape, Size, etc.—In *shape*, chondromata are usually spherical or oval. They are quite often composed of spherical lobules, which give them an irregular and bosselated appearance. They constitute, among neoplasms of the bones, the tumors which are capable of acquiring the largest *size*, varying from that of a nut to 2.15 metres (nearly seven feet) in circumference, as in the case of Sir Philip Crampton's patient.

Transformations.—Chondromata may be invaded by calcareous infiltration in the centres of the cartilaginous lobules. Fig. 801 represents an enormous chondroma which occupied a part of the anterior surface of the sternum and of the neighboring costal cartilages. The cartilaginous tissue had undergone numerous transformations.

The patient was a man 45 years old, who came under my care in the Croix-Rousse hospital. The beginning of the tumor dated back to the age of 10 years. For several months past it had been developing rapidly; the skin was red and inflamed, and there was distinct fluctuation over a large part of the neoplasm. The substance was hard and resisting, being of the consistence of bone in some points. There was acute pain. Upon incision there was an abundant escape of sero-purulent fluid, and I found that I had to deal with a cystic chondroma, with calcified masses, a large part of which was necrosed and was easily detached. The implantation of the tumor upon the neighboring costal cartilages, and its deep connections, permitted only partial ablation, and as complete a scooping out as was possible without opening the mediastinum. The sequelæ of the operation were most simple; but three months afterwards large, fungating, sarcomatous masses had taken the place of the excised tissues.

True bone-formations have been met with in chondromata (ossifying chondromata). Sometimes the tumor is soft and fluctuating over a great part of its surface, and its contents are viscid, ropy, and of a colloid appearance. Cysts may be developed in chondromata, either under the influence of softening, or as a consequence of rupture of the bloodvessels.

Origin.—According to Cornil and Ranvier, chondromata arise from embryonic tissue formed by a process analogous to that of osteitis. According to Virchow, they arise in cartilaginous islets detached from the cartilage of ossification and remaining in the centre of the bone. (Heydenreich.)

Action on the neighboring Tissues.—The *skin* remains for a long time intact and does not give way until after extreme distention. The *bones* are thinned and eroded. The *fibrous tissues* are thinned and perforated. The *vessels* are rarely affected, though some observations seem to show that the cartilaginous substance may penetrate them. The neighboring *joints* are intact and not ankylosed.

Etiology of Chondromata.—Chondromata are most frequently seen in young persons. Some may even be congenital. Patients often refer them to traumas; this is a cause habitually mentioned, and one which should be taken into serious consideration, even if the traumatism acts only by producing a *locus minoris resistentiæ*. Rachitis and heredity have also been charged with the production of chondromata.

Synptoms.—The onset is generally slow and insidious. As to consistence, this varies according to the transformations undergone by the cartilage. When there are superficial cystic cavities it is not rare to find fluctuation. If the chondroma has started in the interior of the bone, it is surrounded by a shell of bone which becomes gradually thinned, and may give rise to the phenomenon of *parchment-like crackling*. A perichondroma, on the contrary,

is enveloped only by the soft and fibrous tissues, which it pushes before it. In some cases, in which the tumor is very vascular, *pulsation* and a *blowing sound* have been discovered. Some tumors are actually *transparent*. This variety is most frequently met with in the fingers, which are so often the seat of multiple enchondromata. The hands often exhibit then several small tumors which resemble each other.

Course.—Ulceration of the integuments does not take place until very late, and when it happens it is the result of inflammation by distention. Partial gangrene of the mass has been observed. Finally, Chassaignac saw one of these tumors suppurate, and I can report also a case of this kind. Pain is a late feature, and is due to compression of the nerves. Chondromata are generally benign tumors, of slow course, sometimes remaining a long time stationary, but sometimes also making rapid advances. At the end of their evolution, when, by successive increase in their size, the skin is broken and suppuration is established, the patients may become cachectic and succumb. The duration of chondromata is often considerable. Such tumors may last ten years, sometimes even twenty years, before giving trouble.

I have said that chondromata can be classed with benign tumors. There are, however, malignant chondromata.¹ In some cases the lymphatics have been involved, and cartilaginous degeneration of the neighboring lymphatic glands has been observed. Visceral infection has also been noted: in the lungs by Bichet, Virchow, Volkmann, Baum, O. Weber, and Heurtaux; and in the spleen by Müller. It is well to remark that in these cases the growths were not chondro-sarcomata, but really true chondromata. Well circumscribed chondromata seem to be less grave than those which are the starting-point of tracks of embryonic tissue. (Heydenreich.) Local recurrence is quite frequent, but does not of itself indicate a malignant tumor. In such a case it is permissible to ask one's self if the operator has not left behind some morbid tissue. Further, it must be considered that, chondromata being multiple tumors, after ablation of a growth of this nature others may be developed in different parts of the skeleton, without there being necessarily a recurrence or generalization.

Diagnosis.—The diagnosis is easy in the hand or in the fingers; but much less simple in other regions. A firm and elastic tumor, large and with a bosselated surface, developed slowly, without pain, without enlargement of the lymphatic glands, without adhesion to the skin, and without cachexia, will suggest the thought of a chondroma. The presence of cysts will in some cases make an exploratory puncture possible, and the detection of cartilage-cells, with or without capsules, will furnish a valuable means of diagnosis. Spina ventosa bears a resemblance to chondroma only at first sight. Sarcoma and carcinoma are distinguished by their malignant course. Cysts of the bones may be more easily confounded with chondromata, as may fibromata; but the latter have generally a smoother and more regular surface.

Treatment.—Medical treatment is absolutely useless. As for certain palliative measures, such as partial ablation, or the opening of cysts which the tumor may contain, they are applicable only to special, well-defined cases. In cases of pedunculated enchondroma, section of the pedicle by the subcutaneous method has been of no service. Ablation is, then, the measure to be resorted to, and the particular operative procedure to be employed must be determined by circumstances.

(1) *Ablation.*—Formerly caustics were employed for the removal of chondromata, or for their destruction in place. But, with the employment of antiseptic dressings, there is now no reason for such a procedure, and prefer-

¹ Walsdorf, op. cit.

ence should be given to the knife. The tumor must be removed freely, so as to prevent recurrence.

(2) *Enucleation*.—This procedure is applicable to enchondromata. Correctly speaking, the medullary canal is to be opened and scooped out through the whole extent in which it is believed that there is any morbid tissue. Dieffenbach seems, however, to think that morbid tissue left behind may become ossified and thus lead to a cure. This is the method recommended by Dr. A. Aubert¹ for certain chondromata of the fingers.

(3) *Resection*.—It may be necessary, in case of a central tumor, to resect the whole portion of bone affected with the degeneration.

(4) *Amputation*.—This is the last resource. It is not rare to see chondromata of the hand which are not of large size, which have no tendency to increase, and which allow the fingers to preserve the greater part of their functions. In such a case it is better to abstain from all surgical interference. Amputation would not be indicated except in case of rapid growth, or of great functional disturbance, when disarticulation should be practised at the next joint. For chondromata of the long bones, where the prognosis is often much more grave, the kind of amputation should be determined by the characters and extent of the neoplasm.

PULSATILE TUMORS OF BONE.

Sarcomata, at a certain stage of their development, may exhibit pulsation and a murmur under the influence of simple dilatation of the bloodvessels. These symptoms are observed especially in giant-celled and in round-celled sarcomata. (Gross.) The same phenomenon may be produced in carcinomata when the vascular element has increased considerably. This is a first variety of pulsatile tumor; but its study belongs to the history of sarcoma and carcinoma. At other times, in the midst of a tissue clearly sarcomatous or carcinomatous, there are found more or less anfractuous cavities, of different dimensions, containing blood and clots, and on the walls of which broken bloodvessels open. These cases constitute a second variety of pulsatile tumor, but their study also belongs to that of sarcoma and carcinoma. Finally, there are found in the bones vast cavities in which blood circulates, brought by vessels gaping in the wall, and containing also clots formed from the constituents of the blood. Their wall is made up of a fibrous web, without any trace of sarcomatous or carcinomatous tissue. In the cavity there sometimes float denuded vessels; the neighboring parts are simply distended and not altered. The dilated afferent vessels have healthy coats, just like the large vessels of the limb. This last variety of vascular tumor of bone has been the subject of an important paper by M. Richet.²

Synonyms.—Erectile tumors of the bones (Breschet). Hæmatomata of the bones (Volkmann). Aneurisms of the bones (Richet, Follin). We shall see that these different denominations correspond to different pathogenic theories.

Pathological Anatomy.—Pulsatile tumors of the bones are developed in the spongy tissue at the ends of the long bones, and especially at the upper end of the tibia. In the second place come the lower end of the femur and the upper end of the humerus. Demongeot de Confevron mentions a case occurring in the middle portion of the radius. The articular extremity is transformed into a shell, the irregular and anfractuous cavity of which has a constant tendency to increase. Sometimes the walls of the cavity are made up of bone-tissue reduced to the state of flexible lamellæ; sometimes the shell

¹ Op. cit.

² Arch. Gén. de Méd., 1864.

of bone is lacking at certain points, and is replaced by thickened periosteum. In Richet's case, the internal surface was covered by a reticulated fibrous layer, which Richet compares to the surface of a ribbed bladder. The tumor is single, its size is large, it may hold several litres of fluid. The contents are constantly pure blood, or blood which has undergone different transformations. The vessels are free from change; injections thrown into the principal arteries fill the cavity. The neighboring articulations are healthy and appear sufficiently protected by the articular cartilage. There is no invasion of the surrounding soft parts.

Nature.—According to Breschet, these cases are comparable to those of erectile tumor. Nevertheless, there is found here nothing but an anfractuous cavity filled with liquid or coagulated blood, whilst erectile tumors are formed of a vascular tissue analogous to the cavernous tissue. The same remark is applicable to cirroid aneurisms. Volkmann admits that the starting-point is the rupture of an artery, whether as the result of a traumatism, or in consequence of atheromatous degeneration of its walls. The case would then be one of false aneurism developed in a bone, but this hypothesis does not at all explain the opening of multiple vessels in the cavity of the tumor. Volkmann would suppose then, with Lebert and Rokitsky, that the sacs result from a telangiectatic transformation of a sarcomatous, and especially of a myeloplaxic tumor. If, on the one hand, it be admitted, as E. Nélaton has proved, that the myeloplaxic tumors are benign and may sometimes remain stationary; and, on the other hand, with MM. Monod and Malassez, that the myeloplaxic cells have a part in the formation of vessels, which has led them to call the myeloplaxic tumors *angioplaxic tumors*, it might be believed that interstitial hemorrhage had begun by pressing back the tissues of the tumor, and had then determined their atrophy. However, in the cases of Parisot and Richet, there was found only fibrous tissue without any trace of a tumor. It will be seen that there is still much to be desired in our knowledge of the pathological anatomy of this affection. Investigations of a number of points are still necessary in order to establish its nature.

Etiology.—Pulsatile tumors of the bones occur oftener in men than in women. They are seen in young patients and in adults. The influence of traumatism is noted positively in four cases out of nine.

Symptoms.—The appearance of the growth is sometimes preceded by pain; when there has been an injury, the disease may start suddenly with acute pain. The tumor forms but a slight elevation, but as it is developed the skin is sometimes seen to become reddened and to be streaked with dilated varicose veins. The consistence is variable; if, at the time of the examination, the tumor is limited by a wall of bone, the sensation called parchment-like crepitation may be felt. If the envelope is osteo-fibrous, there will be found some hard and some depressible points. In one case, the skin could be pushed into the cavity of the bone like the finger of a glove. Pulsation, isochronous with the pulse and accompanied by expansile motion, may appear either at the same time as the tumor, or a little later. These two symptoms disappear on compressing the principal artery of the limb. Fluctuation is perceptible only in tumors without a bony envelope. The blowing sound met with by Richet is not usually present. The *functional symptoms* are as follows: The joint next to the tumor has its movements partly abolished, without being always invaded by the lesion. There are pains in the limbs, caused by compression of the nerves. Painful œdema has also been seen, due to pressure upon the veins of the part. The *duration* of the disease is very variable. In published cases it has varied from three months to seven years.

Diagnosis.—An aneurism of bone may be confounded: (1) With an aneurism developed in the soft parts, without any lesion of the bone; (2) With one of the tumors of bone which exhibit pulsation; (3) With a simple bone-tumor. Aneurisms of the bones have symptoms analogous to those of aneurisms of the soft parts, and it is possible, therefore, to mistake one of these affections for the other. Nevertheless, it is generally easy to distinguish them by the following characteristics: Aneurism of the bone is connected with the subjacent bone; there are often found near its base lamellæ of bone which give the sensation of crepitation; by pressing down upon the tumor, it is noticed that the bone has undergone a loss of substance. Other aneurisms are movable, and but loosely connected with the bone near them; they may be displaced, and they have a much more marked blowing sound. The diagnosis from tumors accompanied by pulsation rests upon the following signs: (1) An aneurism in the bone disappears almost wholly under continuous pressure, while a sarcomatous or carcinomatous tumor is but little affected by pressure. (2) If the principal artery of the limb be compressed, tumescence and pulsation reappear much more quickly in purely vascular tumors. (3) Fluctuation, combined with pulsation and a murmur, constitutes, according to Professor Richet, a clinical sign of great value. In case there is an envelope of bone, an exploratory puncture, giving a jet of arterial blood, will enable one to make the diagnosis. (Jamain and Terrier.)

Prognosis.—These tumors are grave because they destroy the bone upon which they are situated, abolish the function of the limb, and necessitate ligation of the principal artery or amputation.

Treatment.—(1) Ligation of the principal artery of the limb has been employed in five cases, and has been followed by success four times (Lallemand, Roux, Lagout, Demongeot de Confevron); in the fifth case considerable improvement followed, but there was a recurrence after a fall on the knee (Carnochan).

(2) Amputation has been practised in three cases, with one death (Peterson), one recovery (Parisot), and one recurrence (Scarpa). A fourth patient, operated upon by Richet, had secondary hemorrhages which required ligation of the subclavian, the patient dying of pyæmia.

(3) Compression of the principal artery has failed in one case. It seems to me that this method of treatment ought always to be employed at first. After a methodical trial of it, one may think of further surgical interference. To sum up, in cases of pulsatile tumors of the bones, the surgeon should commence by compression of the principal vessel of the limb. If compression fails, he should try the ligature. Amputation should be practised only as a last resort. Electro-puncture, and the coagulating injections recommended by Volkmann, should be utterly rejected. I have given here a summary of the investigations of certain surgeons in regard to aneurisms of the bones, but I feel bound to say that this lesion is extremely rare, and that, in the great majority of cases, very vascular sarcomata have been mistaken for aneurisms—tumors which are truly aneurismal, and which present all the clinical signs of a dilatation situated in the course of a large vessel. In the museum of our Faculty of Medicine are found several specimens of this kind, collected by Marc-Antoine Petit, Gensoul, etc., and designated by the name of aneurism. These tumors required amputation of the limb, and from their anatomico-pathological characteristics it is evident that those surgeons had telangiectatic sarcomata to deal with.

CYSTS OF BONE.

E. Cruveilhier¹ has described cystic cavities which he considers the starting point of intra-osseous abscesses. Their study belongs with that of abscesses of the bones. The same is true of a certain number of tumors which eventually undergo cystic degeneration in some part of their substance. The most important variety of bone-cyst is of parasitic origin—I refer to the hydatid cyst. Finally, true cysts are met with. These last two varieties alone shall occupy us. As they differ only in their pathological anatomy and in their etiology, I shall describe both varieties together. I shall eliminate at the outset a whole variety of cysts which arise in the maxillary bones, and which are known by the names of *dental cysts*, *cysts of the periosteum*, *cysts of the roots*, *follicular cysts*, *dentiferous cysts*. I shall do the same with regard to cysts of the maxillary sinus, and those of the inferior maxilla, which sometimes contain, as Prof. Gosselin has remarked, serum and sero-sanguinolent fluid.

Pathological Anatomy.—Simple bone-cysts are unilocular or multilocular, but much more frequently multilocular. Their size varies. They may attain considerable dimensions, as in Nélaton's case, in which the tumor occupied the femur from the base of the great trochanter to a point two centimetres above the condyles. The internal wall is covered with a membrane having the smooth appearance of serous surfaces, and sometimes presenting fibroid vegetations. These cysts sometimes contain pure serum, sometimes sero-sanguinolent serum, sometimes a viscid liquid like a solution of gum. In multilocular cysts, delicate partitions separate the different cavities.

In almost all bone-cysts echinococci have been found, and in one the *cysticercus cellulosus*. The cyst itself shows nothing peculiar; it is constituted like all hydatid cysts; the bone occupied by the parasite is at first hollowed out into a cavity, which increases as the vesicle is developed. It becomes distended, and the shell of bone ends by being perforated, when the hydatid is covered only by the periosteum. Hydatids usually occur in the spongy tissue; sometimes however they are met with in the medullary canal. In a specimen which I examined some years ago at the Hôtel-Dieu, and which was derived from the practice of a physician in the country, I found several hydatids in the medullary canal of the tibia from a leg amputated the evening before at the point of election. I could not get any history of the case, but a marked hyperostosis, and fistulous tracks which appeared to be old, on the inner surface of the bone, attested the chronic character of the affection.

Situation.—Hydatids are met with in almost all the bones: tibia, humerus, femur, vertebrae, and iliac bones. A number of bones may be affected at the same time. In 1872, in the service of Dr. Léon Labbé, at the hospital of La Pitié, there was a patient who had a large hydatid cyst of the humerus and scapula. Simple cysts of the bones have been seen in the femur by Nélaton, in the humerus by Sir Astley Cooper and Monod, in the tibia by Sir Astley Cooper, in the ulna by Carle,² and in the scapula by Robert.

Nature.—The ideas which we have in regard to cysts [apart from hydatid cysts] of the bones are very incomplete. Volkmann considers them as metamorphoses of solid tumors. In reality there is no certainty on this subject.

Etiology.—Nothing is known relative to the etiology of true cysts. As for hydatid cysts of the bones, their etiology is the same as that of all hydatid cysts. Traumatism seems to play a certain part in their development.³

¹ Sur une forme spéciale d'abcès des os. (Thèse.) Paris, 1865.

² Lyon Méd., 1878.

³ Boncour, Thèse, 1878.

Symptoms.—These tumors generally develop without pain and without inflammation. The first symptom is swelling of the bone. This swelling is at first hard; afterwards parchment-like crackling can be perceived; finally, the shell of bone being destroyed, fluctuation may be noticed, and sometimes the hydatid fremitus. The symptoms observed in the neighboring parts vary according to the region affected. They are, speaking generally, the symptoms of compression. Spontaneous fractures often occur from the slightest cause. As a rule these fractures do not unite, and the diagnosis is established by operations undertaken for the cure of the pseudarthrosis. The neighboring joints may be involved. In some cases the cyst suppurates under the influence of a traumatism or of surgical intervention.

Diagnosis.—The diagnosis is almost impossible at all stages of the disease, and in the later periods it can only be established by exploratory puncture.

Treatment.—(1) *Puncture.*—Puncture, whether simple or combined with irritant injections, does not give satisfactory results.

(2) *Incision.*—This procedure consists in opening the cyst freely through its whole extent, emptying it entirely of its liquid and of all the hydatid sacs, and leaving to suppuration the work of cure. The contraction of the sac does not commence until after several weeks, and complete recovery may be delayed more than a year.

(3) *Resection.*—This consists either in gouging out the bone, if it is not invaded through its whole thickness, or in a true resection involving a greater or less length of the diaphysis. The subperiosteal method ought to be carried out as strictly as possible.

(4) *Amputation* is the last resource, in cases in which the cyst occupies too great an extent of the bone for the employment of milder measures.

SARCOMATA OF BONE.

History.—The tumors which are at the present day known as sarcomata of bone, have a history which may be divided into three periods. The first period is one of entire confusion. J. L. Petit and Sir Astley Cooper called them exostoses and carnifications. Sir Astley Cooper, however, classified them according to their point of origin, and divided them into *fungous medullary exostoses* and *fungous periosteal exostoses*. The word *osteosarcoma*, which appeared with Samuel Cooper, Boyer, and Richerand, was up to the time of Dupuytren synonymous with cancer of the bones, and it was again cancer of the bones which Bérard described.¹ Nélaton considered sarcoma of the bones as the second form of cancer; and the same is true of the authors of the Compendium. The second period is characterized by the preponderating influence of micrographic researches. Lebert studied the fibroplastic tumors, Robin the embryoplastic, and Paget the myeloid, which were analogous to the medulla of the bones, and which Robin divided into myeloplaxic and medullo-cellular tumors; Virchow restored all these tumors to the class of sarcomata. Finally, the third period is that in which an effort has been made to reconcile clinical experience and histological data. H. Gray, Robin, and E. Nélaton, seek to distinguish microscopically certain benign tumors which form the myeloplaxic or medullo-cellular class of myeloid tumors. This distinction is also accepted as well defined by MM. Verneuil and Marchand,² but some malignant cases have been recorded, and certain of these tumors include anatomical elements which connect them with the

¹ Dictionnaire en 30 volumes. Art. Ostéosarcome.

² Dict. Encyclopédique. Art. Moelle des os.

other sarcomata by insensible gradations; so that, while treating them as a separate group, I shall include them in the grand class of *sarcomata*. Virchow has added to the tumors already classified a variety formerly described by Müller—*osteoid tumors*. I shall devote a few words to them. Finally, I shall describe in a third group the *fasciculated*, and the *encephaloid sarcomata*, neoplasms which have often been thrown together under the name of *osteosarcomata*. We find them thus described by Schwartz.¹

The sarcomata are situated on the long bones oftener than on the short bones, on the lower limb oftener than on the upper, on the bones near the trunk oftener than on bones remote from it, on the extremities oftener than on the body of the bone, and this because of physiological considerations to which I have already referred. Usually the disease begins as a single tumor, but under some circumstances several bones are attacked simultaneously, without there being any possible question of generalization. In a patient under my care, there appeared, at the same time with a sarcomatous tumor of the upper end of the fibula, a number of other tumors of the same nature on the cranium; these neoplasms were absolutely contemporaneous. The size of the original tumor is variable; it may reach a considerable development, and especially in young subjects. I have seen sarcomata of the femur six times the size of the thigh. In a case of Herrgott's, the limb could not have been put into a potato-bag. The consistence is variable in different tumors, and even in different parts of the same tumor. The sensation of crepitation is frequently perceived; this is sometimes the parchment-like crepitation, and sometimes a crepitation caused by the breaking of trabeculae of bone, like the crackling of an egg-shell. This peculiar noise, which one does not forget when it has been once distinctly heard, is often of capital importance for diagnosis. The hard tumors push away the organs, distend them, separate them, and cause their atrophy. The soft tumors at first separate the tissues, but then permit themselves to be depressed and to receive the imprint of neighboring organs, in the form of depressions and grooves. The compression acts in different ways on different organs. Compression of the nerves gives rise to paralysis of the innervated territory, to neuritis, and to trophic disturbances. The arteries are rarely destroyed, and remain permeable, though surrounded by the tumor. The veins are flattened, obliterated, and invaded by sarcomatous outgrowths, which protrude from their internal wall and may become the starting-point of emboli. The aponeuroses are thinned, and afterwards perforated. The distended skin becomes frayed, and sloughs, when the tumor has attained a considerable size.

MYELOID TUMORS.—*Synonyms:* Medullo-cellular and myeloplaxic tumors; central or myelogenic sarcomata.

Pathological Anatomy.—The maxillæ are the bones oftenest affected, then come the parts of the skeleton supplied with red marrow, the epiphyses of the large bones, the sternum, the bodies of the vertebrae, etc. M. Ollier² found seven myeloid tumors of the upper jaw made up of myeloplaxes; once also the lower jaw, the vertebral column, one of the parietal bones, the tibia, and the phalanx of the index were affected with myeloplaxic myeloid tumors, twice the femur was invaded, and in two other cases the same bone presented a tumor with medullo-cells. In a general way these tumors have a double origin: they may be peri-osseal or intra-medullary, that is to say, periosteal or central. *Periosteal* neoplasms have been rejected by Virchow in fibro-plastic sarcomata and in osteoid sarcomata. According to other authors, these tumors

¹ Ostéosarcomes des membres. (Thèse d'agrégation.) Paris, 1880.

² Thèse. Montpellier, 1855.

are a transition stage between benign and malignant growths. Verneuil and Marchand consider them as belonging clearly to myeloid tumors. They rest upon the bone, with which they have cellulo-vascular attachments. The bone-tissue at their seat may show only superficial erosions, but sometimes the depression penetrates to the medullary canal. *Intra-osseal* tumors are by far the most frequent. They are encysted or diffused. In the encysted form, in proportion as the bone is destroyed by the encroachments of the tumor, a sub-periosteal new formation forms a more or less thick shell of bone around it. When this shell is wanting at any part, the wall of the cyst is osteo-fibrous. In the diffuse form, neoplastic masses of variable size are spread through the much enlarged areolæ of the bone. The bone then acquires a peculiar cavernous appearance. Vascularization is very abundant, and interstitial hemorrhages, by filling the areolæ with blood, produce a resemblance to aneurism. Nélaton has spoken of a form called perforating, which is remarkable for the rapidity with which central tumors perforate the bone and spread outside of it.

The neighboring tissues—aponeuroses, muscles, tendons, vessels, and nerves—are pressed backwards and asunder, and hollow out for themselves depressions and grooves in the neoplasm without being involved in the degeneration. The cartilages oppose an almost insuperable barrier to invasion, and, in order to penetrate to the joints, the neoplasm goes around them. E. Nélaton has spoken of two varieties of myeloid tumor: one in the crude state, the other in the state of softening. Sub-periosteal myeloid tumors have a firm and resistant consistence, such as is rarely presented by intra-osseal tumors. The tissue in the intra-osseal form is at first firm, elastic, and quite coherent, but is at a later period transformed by softening into a substance without more cohesion than the substance of the brain. When in this stage hemorrhages occur, they transform the morbid growth into a brownish mass which might be mistaken for clots. Tumors composed of myeloplaxes have on section a red, or reddish-brown, color. Those which are made of medullo-cells have a yellowish-gray tinge.

Histological Structure.—Myeloplaxes and medullo-cells are the fundamental element of these tumors. In such neoplasms they have the same form as in the medulla, but often their size is larger. Fibrous trabeculæ traverse the tumor, and form a sort of reticulum, in the meshes of which the myeloid cells rest. But this fibrous tissue is only accessory, and its greater or less quantity modifies the consistence of the tumor. In the centre of the mass there is often found a trabecular network of perfect bone-tissue. (Verneuil and Marchand.) These tumors present multiple degenerations: fatty, cystic, telangiectatic. Cavities are found in them, filled with blood from interstitial hemorrhages; and masses of bone, which have sometimes led to their being considered as ossifying tumors.

Etiology.—Myeloid tumors are usually developed below the age of thirty years, and oftener in men than in women. Traumatism has been noted as a predisposing cause, as well as repeated irritations of one point of the skeleton.

Symptoms.—These tumors are developed either in the mouth, inside or outside of the dental arches, or—but much more rarely—in an epiphysis or even a diaphysis of a long bone. They are adherent to the bone, and are not movable at any period of their evolution. Peri-osseal myeloid tumors are hard and firm. No notion can be formed of the consistence of intra-osseal tumors until they have perforated the compact substance; a little before which occurrence, parchment-like crepitation may sometimes be perceived, even on light pressure. The consistence varies also with the points examined; there are few tumors which exhibit differences of consistence in different points in

so distinct a manner. These tumors are often the seat of pulsation, of expansile motion, and even of a murmur. Their complications are: plastic arthritis due to proximity, spontaneous fractures, distortions of the joints, etc. (Terrier.) The first stage of development of these growths usually passes unnoticed. Sometimes they are first observed after a traumatism, which may, moreover, provoke rapid evolution of a tumor which up to that time had been slowly developed. These tumors are usually painless, except in cases with a rapid course. The health and constitution of the patients remain a long time unaffected. Verneuil thinks that these tumors do not invade the lymphatic glands; in a case of Ollier's, however, the glands were implicated. The size of the mass, ulceration of the skin from stretching, consecutive suppuration, interstitial hemorrhages, and pain, end by exhausting the patient.

Diagnosis.—The diagnosis is not always easy. An exploratory puncture generally gives exit to a few drops of blood, a thing which does not occur upon puncture of a fibroma or chondroma. Central tumors cannot be diagnosed with certainty at the outset. The absence of glandular engorgement, and the integrity of the general health, may lead to a thought of these tumors.

Prognosis.—Myeloid tumors are benign, but perhaps less so than E. Nélaton seems to think. There are, in fact, rapid and malignant cases—quite rare according to Verneuil, but quite frequent according to Virchow, especially when the affection is seated in the bones of the limbs.

Treatment.—(1) *Ligation of the Artery of the Limb.*—This operation was done by Dupuytren in a case in which there was pulsation, and it gave a good result for seven years, when recurrence took place, making amputation necessary. I only mention this case, which probably rests upon an inexact diagnosis. (2) *Simple Excision.*—Excision, which has been employed especially for periosteal tumors, is an incomplete operation, to which cauterization or scraping of the surface of the bone must be added. (3) *Excision of the Tumor and Ablation of a portion of the Bone.*—In this, ablation of the tumor is followed by scooping out of the bone with the gouge and mallet, through the whole extent which may be supposed to be affected. (4) *Partial or total resection* is especially applicable to the maxillæ. (5) *Amputation*, or better, *disarticulation*, is the procedure especially applicable to the bones of the limbs.

After having described myeloid tumors, I cannot pass over in silence a variety of growth described by Dr. Bouveret,¹ which he has called *osteoblastic tumor*. This is a neoplasm composed essentially of the elements which are met with in bone-marrow; but by its generalization this tumor is assimilated to tumors of greater malignity.

The sarcomata which I am next about to describe are of two varieties, when regarded from the standpoint of pathological anatomy. Their symptoms closely resemble those of some tumors of which I have spoken already. I shall consider them especially in regard to their malignity.

FASCICULATED SARCOMATA.—*Synonyms:* Fibro-plastic tumors; spindle-celled sarcomata; recurrent fibroids (Paget); fibro-nuclear sarcomata (Bennet). *Situation.*—These neoplasms are met with especially at the ends of the bones, but sometimes also in the diaphysis. They are situated preferably in the long bones, as in the lower end of the femur or the upper end of the tibia; but they are also seen in bones of the cranium, of the face, of the tarsus, etc. Their size is often considerable; their shape is rounded or oval; they are smooth, and rarely bosselated. Their starting-point may be the periosteum

¹ Thèse de Paris, 1878.

or the centre of the bone. Central tumors have a bony, or an osteo-fibrous shell, which is wanting in periosteal tumors, in which there is from the first only a fibrous shell furnished by the periosteum, which is usually consecutively involved. The consistence of these tumors is usually firm and elastic. They creak under the blade of the knife. On section, the surface appears smooth and shining. The color is light gray in some places, and rosy at others, and extravasations of blood are sometimes seen.

When one of these tumors is left for some time exposed to the air, a little milky juice can be obtained by scraping. It is not unusual to find in the tumor bony trabeculæ, radiating or in the form of needles.

Microscopical Examination.—These tumors are made up of longer or shorter fusiform cells; those with small cells are the softest. Myeloplaxes are found in them, as accessory elements. They undergo cystic degeneration more rarely than other neoplasms, and are but slightly vascular.

ENCEPHALOID SARCOMATA.—*Synonyms:* Round-celled sarcomata; embryoplastic tumors; globo-cellular sarcomata; granulation-tissue sarcomata (Billroth). *Situation.*—Encephaloid sarcomata are situated in the extremities of the long bones, in the short bones of the foot and of the hand, and oftener than the fasciculated sarcomata in the diaphyses of the large long bones. Their shape is globular; they are smooth; those which are developed at the expense of the central canal have an enveloping capsule, partly bony and partly fibrous; those which arise in the periosteum have a fibrous capsule which is soon invaded. When these tumors are cut, the surface of the section presents an appearance which has been likened to the milt of fish, or to the cerebral substance. Exposure to the air makes it possible to collect on the surface a much more abundant juice than in the case of the preceding tumors.

Microscopical Examination.—The fundamental element is the round, embryonic cell, the size of the white corpuscles of the blood. As accessory elements we meet with connective tissue of the ordinary kind, or reticulated tissue—which has led Rindfleisch to give this variety the name of the lymphadenoid form—or a very vascular tissue determining a form called alveolar by Billroth. These tumors often undergo cystic and telangiectatic degeneration, and are the seat of interstitial hemorrhages. I shall now enter upon the study of conditions common to all the sarcomata.

Condition of the Neighboring Articulations.—Gillette considered integrity of the joints as nearly constant, and as constituting a good diagnostic sign. Dr. Poincot, who agrees in this with S. W. Gross, of Philadelphia, opposed this assertion at the Society of Surgery. The joints are affected in some cases, and more frequently by central than by periosteal sarcomata. At the beginning there are found more or less sanguinolent effusions. The cartilage resists a long time, but sometimes it is perforated. At other times it is detached in its totality, and the neoplasm, penetrating the peripheral parts, pushes outgrowths into the interior of the joints. In some cases both articular extremities are involved.

Spontaneous Fractures.—Spontaneous fractures often occur in cases of osteosarcoma of the long bones. Two cases may present themselves: 1. The bone has already been invaded by a periosteal sarcoma, and the two fractured extremities are lost in the midst of the mass of the neoplasm; 2. A central sarcoma has rarefied the bone, a fracture has taken place, and at the end of a few days a sort of expansion of the neoplasm occurs between the fragments, which expansion may be mistaken for callus in the process of formation. These fractures very rarely consolidate; sometimes, however, callus may be formed, but it rarely comes to completion. The limb is removed, or the patient dies

beforehand of cachexia. The embryo-plastic sarcoma appears to predispose to this more than do the other forms.

Generalization of Bone-Sarcomata.—Sarcomata of the bones first invade the whole of the bone in which they are situated. This invasion takes place very rapidly in central sarcomata. In periosteal sarcomata, it is necessary that the tumor shall have first penetrated to the medullary canal. The tumor may extend to the neighboring bones, especially in fasciculated sarcoma. This fact is important in regard to operations. Involvement of the lymphatic glands is occasionally seen. Finally, visceral generalization is extremely common, especially in the fasciculated periosteal sarcoma, which has led S. W. Gross to say that spindle-celled periosteal sarcomata become generalized in almost all cases.

Etiology of Bone-Sarcomata.—The causes of sarcomata of the bones are not well understood. Their occurrence has been noted at the seat of an old fracture, or an old sprain, or after a traumatism. This explanation of their etiology has been considered unworthy of attention by many surgeons, but I do not share such a way of thinking. It is certain that many cancerous tumors appear without appreciable cause in patients having a predisposition to such a development; but it is not less true, if account be taken of the history given by the patients, that traumatism has often been the starting-point of a sarcoma. I have often met with such a cause, and I confess that I cannot comprehend why violence capable of producing inflammatory lesions in the contused bones, may not, in predisposed subjects, play the part of a determining cause in the development of neoplasms. These tumors appear between the ages of 20 and 40 years, but especially before that of 30 years. They are, according to Schwartz, twice as frequent among men as among women.

Symptoms of Bone-Sarcomata.—(1) *Stage of Onset.*—The onset varies with each case. In the greater number of cases attention is attracted by pain at some point, dull, intermittent, increased by fatigue, sometimes rheumatic or neuralgic in character, and acute enough to prevent sleep. In other cases the appearance of an indolent tumor precedes the pains. Finally, in some cases the pains and the tumor appear simultaneously. Central sarcomata are said to be more painful than periosteal; and sarcomata of the diaphyses to be more painful than those of the epiphyses. In some cases a spontaneous fracture is the initial phenomenon.

(2) *Stage of Full Development.*—The symptoms of this stage may be divided into three groups: (a) common symptoms, independent of the seat of the tumor; (b) symptoms depending on the proximity of a joint; (c) symptoms peculiar to a tumor of the diaphysis.

(a) *Common Symptoms.*—There is a swelling which is continuous with the bone, and the base of which it is always necessary to examine, as the tumor may have mobile prolongations. The integuments, which are generally healthy, are stretched, but of normal color, and they do not ulcerate until late. In about a third of the cases, dilated veins are seen. The muscles of the affected region are atrophied. Tumors of central origin often present, during some period of their evolution, parchment-like crepitation. Fluctuation may be met with in soft tumors, or in those affected by cystic degeneration. In some cases pulsation and a blowing sound have been noticed. The local temperature may be slightly elevated. This local rise of temperature is sometimes quite marked, and is proportioned to the more or less rapid development of the tumor. At the beginning, the general health is most often good. Sometimes slight emaciation is noticed, and a peculiar fever, called sarcomatous. (Verneuil.)

(b) *Symptoms depending on the Proximity of a Joint.*—The swelling assumes a peculiar shape which has been compared to that of an enormous leg of mutton. The limb, or the limb-segment, is in a position analogous to that which is assumed in cases of arthritis. There is a greater freedom of movement than would, at first thought, be supposed. It is important, however, to be careful not to confound movements of the joint with those which might result from a fracture near the articulation.

(c) *Symptoms peculiar to a Tumor of the Diaphysis.*—The shape of the tumor may be globular, if the tumor is lateral; fusiform, if the tumor has involved the whole circumference of the diaphysis; club-shaped, if the tumor is near the epiphysis. In a patient fifteen years old, on whom I practised, at the Croix-Rousse Hospital, disarticulation of the left thigh for sarcoma of the diaphysis, the whole shaft was involved and was transformed into an enormous sarcomatous mass. On section, the two connecting cartilages were seen to constitute a barrier above and below. The consistence is hard to estimate on account of the layers of muscles. The neighboring joints are completely free. If the tumor is situated in a part of a limb containing two bones, the unaffected bone may be pushed aside, luxated, or consecutively implicated.

(3) *Stage of Cachexia and Infection.*—It is to be noticed that this stage usually coincides with that of ulceration. Elevations are formed upon the tumor; the distended skin becomes adherent, thinned, and assumes a purple color. A slough forms, ulceration succeeds this, and sarcomatous excrescences protrude. At this time various hemorrhages may supervene, either from the ulceration of the skin, or from the sarcomatous excrescences. Fever is lighted up, and the patient rapidly grows weak under the influence of septicæmic complications. In extremely rare cases, abscesses have been seen to develop in the neighborhood. Then emaciation comes on, and the patient has an earthy, sub-icteric complexion, and dies. Death may occur from hectic, from hemorrhage, from septicæmia, or from generalization of the affection. Generalization is especially apt to occur in the lungs, and this occurrence is sometimes revealed by hæmoptysis, but often nothing would lead one to suspect it. These latent pulmonary lesions are sometimes hastened by operations undertaken for the removal of the tumor. When secondary masses are present in other organs, peculiar symptoms will be found according to the organ involved. Recurrence after operation may take place: in the operation-wound, in the cicatrix after healing of the wound, at a point higher up the limb, or in internal organs. The latter is not a recurrence but a generalization. Lymphatic involvement of a sarcomatous nature is said to be rare. Some surgeons even find in this absence of adenopathy a sign by which sarcomata may be diagnosticated from other varieties of malignant tumor. The observation is correct; but the fact must not be lost sight of, that, when the skin is involved by the neoplasm, and ulcerated, swelling of the lymphatic glands is the rule.

Course of Bone-Sarcomata.—Sarcomata of the periosteum seem to progress by interrupted stages; central sarcomata have a more continuous course. The duration of life, without surgical operation, has varied from two to forty-six months. The most malignant tumors seem to be the encephaloid. Melanotic sarcomata of the bones are usually seen in the stage of secondary cancer, from generalization; but in some cases the bone-tissue is invaded by continuity. Thus, in an old woman on whom I practised disarticulation at the ankle-joint for a melanotic sarcoma of the foot, the starting-point of which was the skin on the dorsum, the greater part of the bones of the tarsus were infiltrated with melanotic nodules.

Diagnosis.—*Fibroma* of the bones is rare. Its slow course and hard consistence may make its presence probable, but not certain. *Chondroma* has nodes and bosses; it is often situated on the fingers, does not infect the lymphatic glands or the viscera, and has a slow and benign course. *Cysts* may be recognized by exploratory puncture. *Carcinoma* develops very rapidly, but a diagnosis cannot always be made, unless one can find on the patient other tumors of the same nature. *Osteo-sarcoma* may be diagnosed by taking into account the course of the affection, its manner of development, and the characteristics of the tumor. A valuable sign, when it can be perceived with the fingers, is the bony crepitation of which I have already spoken.

Treatment.—The only rational treatment is ablation, whenever it is possible. But it is necessary to remove absolutely all of the new growth. Every sarcoma has a local and benign stage, says Schwartz. It is advisable therefore to operate as soon as possible. If there are enlarged lymphatic glands, they should be removed; if their removal is not possible, one may hesitate to interfere, since the operation will necessarily be an imperfect one. Generalization, whether visceral or osseous, contra-indicates operation. One may, however, be induced to interfere if the principal tumor be easy to operate upon, or if it be the seat of grave symptoms, whilst the secondary tumors do not immediately threaten life. In a child six years old, afflicted with an enormous ulcerated sarcoma of the right femur, a painful tumor and the seat of repeated uncontrollable hemorrhages, I did not hesitate, in spite of large lymphatic glands in the groin, to practise amputation in the middle of the thigh. By means of the antiseptic method I secured complete union by the first intention. Three weeks afterward, the child could not be recognized; his general condition had become excellent; he laughed, and played upon his bed. He died five months afterwards, carried off by visceral generalization. Is it permissible to amputate in the continuity of the affected bone? This question can be answered in the affirmative in cases in which there are well-circumscribed, benign tumors, and sometimes also when the tumor is situated in the femur, since disarticulation at the hip-joint is too grave an operation for one not to hesitate to practise it at the outset. Nevertheless, in the majority of cases recourse should be had to remote disarticulation. Resection is applicable to benign tumors alone. Ligation of the large arterial trunks has seemed to succeed two or three times; but it ought not to inspire any confidence.

OSTEOID TUMORS.

The name of osteoid tumors is applied by authors to tumors of very diverse nature; and this confusion of terms is the cause of much obscurity. (Heydenreich.) Müller, in 1843, was the first to study them, and he considered them as malignant. Lebert, in 1845, classed them with homologous tumors, and looked upon them as benign. Stanley insisted on their malignancy. Virchow, studying the development of the bones, found in the bones of rachitic children a tissue which he called osteoid, and which he erroneously considered to be bone-tissue in the process of physiological formation, but which is peculiar to rachitic bones. Osteoid tumors will, in these pages, be regarded as neoplasms formed of the osteoid tissue of Virchow.

The following are the terms in which Cornil and Ranvier describe these growths: "An osteoid tumor is made up of trabeculæ of different form and dimensions, composed of a homogeneous or obscurely fibrillated refractive substance, often infiltrated with calcareous granules, containing angular corpuscles. The trabeculæ are separated by fibrous tissue in which the vessels run." "There are almost always scattered through them islets of carti-

lage which are developed in the fibrous tissue between the trabeculæ (osteoid chondromata).” “Calcareous infiltration in some part of these tumors is almost the rule. Isolated granules are deposited in the fundamental substance of the trabeculæ, but the corpuscles surrounded by this deposit do not thereby become bone-corpuscles. These corpuscles never exhibit any other than incomplete prolongations, and in small number. The fundamental substance never becomes lamellar.” “These tumors are formed of a single mass, or if they are lobulated, they never show this disposition in as marked a degree as do ordinary chondromata.”

Examination of these tumors with the naked eye does not reveal any characteristic signs. It is only by the microscope that their anatomical diagnosis can be made. Osteoid tumors arise most frequently under the periosteum. They surround the bone and adhere to it. The cortical substance may contain cavities, or may be perforated; but it is always possible to find the old bone in the tumor. The periosteum is pushed back, and afterwards destroyed, and finally the neighboring parts disappear in their turn. Osteoid tumors are situated on the long bones, especially on the femur and the tibia. They sometimes attain enormous dimensions. Their hardness is very marked, their surface is smooth and has only slight rugosities. There is little tendency to ulceration. The age of the patients varies from seventeen to fifty-five years. (Heydenreich.) The course of these tumors is that of malignant growths; they invade the soft parts and the adjacent bones. Osteoid tumors recur in their original position, and become generalized. Metastatic growths are often situated in the lung. A clinical diagnosis is impossible; it can only be said that the tumor is a malignant one. The treatment consists in ablation, if this be possible. When a limb is affected, amputation should be practised above the affected bone.

LYMPHADENOMATA OF BONE.

Lymphadenomata of bone are findings of the dissecting-room. They are usually secondary growths in patients affected with generalized lymphatic tumors.

EPITHELIOMATA OF BONE.

Primary epithelioma of the bones is rare, while secondary epithelioma resulting from propagation of a primary cancerous lesion of the soft parts is relatively frequent. Classical authors do not speak of primary epithelioma of the bone-tissue; and the only complete observation of an affection of this kind has been published by M. Cornil.¹

My attention was called for the first time to cases of this sort by M. Ollier, who, in his long clinical experience, has had opportunity to see several examples of the kind. In all cases the patients are somewhat aged, usually between fifty and sixty years, or more, and have been affected in their adolescence with more or less acute juxta-epiphyseal osteitis of a long bone. These inflammatory affections are accompanied by necrosis of the bone-tissue, by abscesses which leave behind them one or more fistulous tracks, which sequestra or fungosities keep open for years. Many a time have I seen patients who have had fistulæ for twenty or thirty years, and in one case the fistulous track had lasted for fifty-one years. Under the influence of causes more or less well defined, but of which the age of the patient must

¹ Journal d'Anatomie (Robin).

form an important part, an inflammatory irritation continues without cessation; the local phenomena are modified, and a canceroidal, intra-osseous transformation occurs. The mechanism is certainly the same as in the canceroidal degenerations of old ulcers of the tongue, and of old ulcers of the leg or other part (canceroid following old issues), so that theoretically bone-tissue ought not to be primarily the seat of an epithelioma. The objection indeed is only apparent, since it may be admitted, in fact, that the transformation begins in the skin, more or less depressed and invaginated at the bottom of the sinuses; that the medulla and the bone-tissue are affected secondarily; and that it is especially on account of the structure of the medullary tissue that rapid infection follows. I am the more willing to admit this view, because, in a patient seen in my hospital service, and in whom there was a primary epithelioma of the left femur, with old fistulous tracks, the skin surrounding one of these was manifestly the seat of epitheliomatous granulations, over a space the size of a franc-piece. I examined some of these granulations microscopically, and they belonged to the variety called lobulated epithelioma.

In such cases the pains are sometimes quite severe, and the bone appears to be the seat of hyperostosis; it may even acquire a considerable size, but the shape of the hyperostosis, and especially the history, do not admit of the supposition that the tumor is an osteosarcoma.

The constant sign is the escape of a more or less abundant, sanious, fetid liquid. The fetor of the excreted products is extreme; they have the peculiar odor of the secretions of epithelial cancer. But it seems that, from the fact that the lesion is situated in a cavity accessible to the air, as is also the case in cancers of the orifices and of the natural passages of the body, they acquire a peculiar degree of fetor. It is first by the odor, as M. Ollier has justly pointed out, that the diagnosis is established. In some autopsies that surgeon found the medulla of a whitish-yellow hue, transformed into a veritable sebaceous material, and with a certain consistence which made it comparable to a stick of wax. Any of the bones may be affected with primary epithelioma. M. Levrat, an *agrégé* of the Faculty of Medicine, has reported to me the case of a patient in whom the calcaneum was the seat of a primary epithelioma. There was an opening in the skin on the outer side as large as a fifty-centime piece, leading into a vast cavity in the bone. There was a flow of sanious and fetid liquid (a fetor *sui generis*) from this orifice. The patient had been treated up to that time for osteitis. She declared that the affection had begun in the deep tissues. Esmarch and Nicoladoni have also reported cases of epithelioma developed in the cloacæ of necrosis.

The prognosis is extremely grave. On account of the diffuse character of the lesions, if the surgeon can interfere in time, disarticulation should be preferred to amputation in the continuity.

In a man forty years old, who had been subjected a year before by Professor Desgranges to amputation for an epithelioma of the leg following an ulcer, the amputation being done at the point of election, there was a recurrence after a few months. When I saw the patient, who had entered my wards in the hospital, the tumor reached up to the knee-joint, and there were extremely acute pains in the stump, probably from epithelial infiltration and compression of the sciatic nerve. As the patient was already cachectic, and had enlargement of the lymphatic glands of the groin, I did not think it right to practise disarticulation at the hip-joint, but amputation in the middle of the thigh. There was recurrence in the wound by the time it had cicatrized, and the patient succumbed some months after the operation.

Secondary epithelioma occurs especially in the face and in the legs. In

the former situation, it necessitates as radical an ablation of all the diseased parts as is possible. In the lower limb, the question is between amputation of the thigh and disarticulation of the knee-joint. With modern antiseptic procedures, I prefer the latter operation, which gives much the better result from a functional point of view. Epitheliomata of the bones, whether primary or secondary, are rarely accompanied by generalization, though they very frequently give rise to enlargements of the lymphatic glands. But when the tumor is intra-medullary from the beginning, as in primary canceroid, it soon causes cachexia, very probable because of the development of the affection in a tissue as vascular as the marrow of bone.

CARCINOMATA OF BONE.

Although the majority of the malignant tumors described by the ancients under the name of cancer of bone, belong to the class of sarcomata, nevertheless a certain number are primary carcinomata. (Volkmann, Cornil and Ranvier.) Most often, carcinomata of the bones are secondary, whether they result from the propagation to the bone-tissue of carcinomatous products of the soft parts, or whether they are deposited in the bones as the result of generalization of primary carcinoma of the soft parts or of the viscera. (Jamain and Terrier.)

Pathological Anatomy.—The commonest form of carcinoma of the bones is the encephaloid, which often exhibits great vascular richness. Primary carcinoma, which occurs especially in the bones of the face, cranium, vertebral column, and pelvis, in the epiphyses of the large long bones, and finally in the sternum, is seen in two distinct forms—the circumscribed, and the infiltrated or diffuse. The circumscribed variety appears in the form of bosselated masses, of variable consistence, pretty well limited, and sometimes covered with a true fibrous capsule, sometimes with a very fragile shell of bone, which is never present except at the beginning. When the carcinoma is infiltrated or diffuse, it is seen in masses scattered through the medulla, either of the diaphysis or of the epiphysis. This form, which has been studied and described by Forster, attacks a large number of bones at the same time, and generally starts in the vertebræ. The bone-tissue, destroyed by the neoplasm, loses all power of resistance. Accordingly fractures are seen to occur, or rather deformities analogous to those of osteomalacia, whence this variety has received the name of carcinomatous osteomalacia. (Forster, Volkmann.) Secondary carcinoma is usually met with after cancer of the testicle, of the uterus, or of the breast. It may be situated in the majority of the bones, especially in the spinal column, in the cranium, and in the pelvis. (Follin, R. Volkmann.)

Etiology.—Carcinoma of bone seems to occur almost equally in the two sexes, although secondary carcinoma of the vertebral column, which ordinarily follows carcinoma of the breast, is most frequent in women. The age of the patient is usually from forty to fifty years.¹

Symptomatology.—The pains in carcinoma of bone are acute, and appear early. Far from lessening with time, they only increase in severity as the tumor enlarges. The morbid mass sometimes attains a considerable size. Its consistence is usually unequal, certain parts being remarkably soft, and even exhibiting a false fluctuation, which may lead to the belief that there is an abscess, especially if the skin is hot and red. Parchment-like crepitation is rare. On the other hand, it is quite common to find pulsation,

¹ Verneuil et Marchand, Dict. Encyclopédique des Sciences Médicales, art. Os.

expansile movement, and a murmur (Bardeleben), which may lead to carcinoma being mistaken for an aneurismal tumor of the bone. The integuments which cover the growth are distended and thinned. They are very vascular, and are soon destroyed, the neoplasm ulcerating, and giving rise to more or less serious hemorrhages. Spontaneous fractures may complicate both primary and secondary carcinomata of the bones. In a case of carcinoma of the neck of the femur, mentioned by Volkmann, the physician who treated it had believed that it was a coxalgia. A fracture occurred, and this was taken for a spontaneous luxation. The autopsy corrected the mistake that had been made. In carcinoma of the bones, the lymphatic glands are invaded or engorged oftener than in sarcoma. Generalization is constant. Death is the inevitable termination of the affection if left to itself, the mean duration of the disease being then about a year and a half. Holmes found that in twelve cases out of twenty-eight, death occurred in the course of the first year; in five of these cases the affection had not even lasted six months. Secondary carcinoma is ushered in by more obscure phenomena; the pains, tumefaction, and deformities, however, should attract the attention of the surgeon. Spontaneous fractures sometimes have a certain tendency to repair, but almost always the fragments end by remaining ununited. (Malgaigne, Nélaton, R. Volkmann.) Nevertheless, more or less temporary consolidations have been reported. (Follin.)

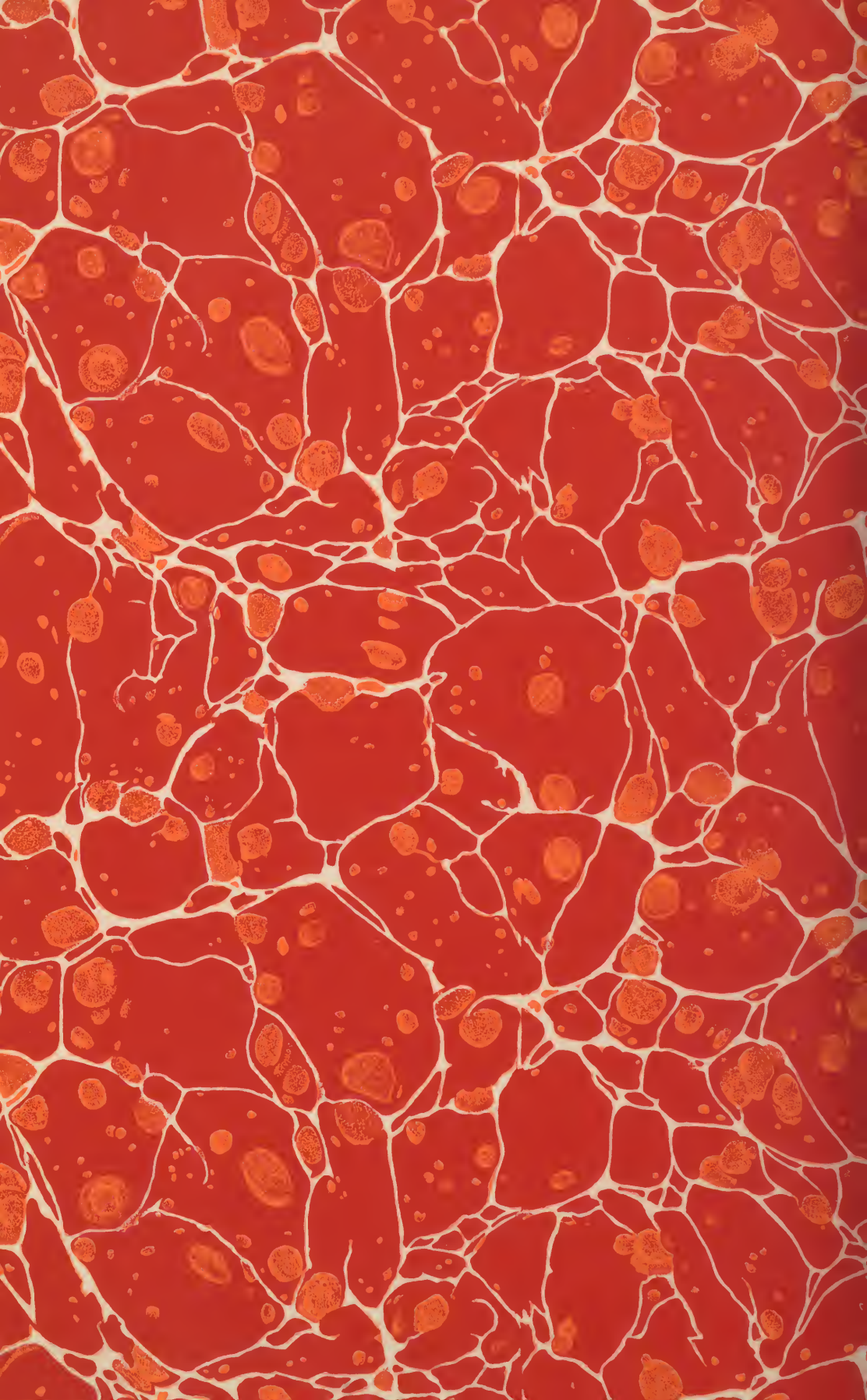
Diagnosis.—In general, carcinoma, rather than sarcoma, attacks patients of a certain age. Its course is more rapid, the pains are acute and persistent, invasion of the soft parts and ulceration of the skin take place early, engorgement of the lymphatic glands is more common. Finally, generalization is almost constant, and may occur very early. Diffuse carcinomatous infiltration sometimes strongly resembles osteomalacia; but the latter affection usually attacks a greater number of bones, and affects the general condition less rapidly. As for the diagnosis of secondary carcinoma of the bones, it rests entirely upon the detection of the primary tumor which has given rise to it.

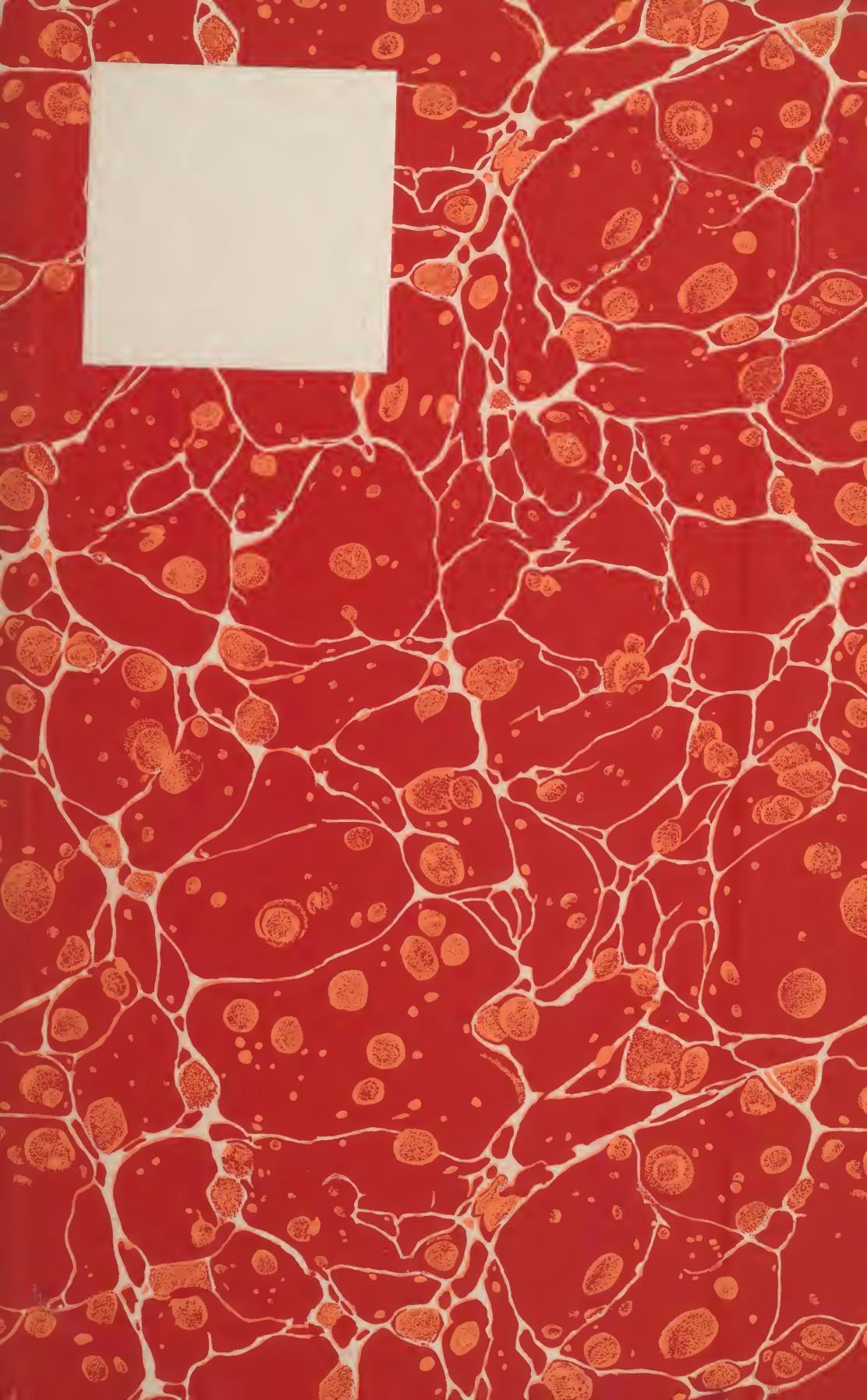
Prognosis.—The prognosis is always grave, on account of the frequent recurrences, and of the tendency to generalization. (Jamain and Terrier.)

Treatment.—Whenever it is possible, the whole bone affected with carcinoma should be removed; that is to say, disarticulation is to be preferred to amputation in the continuity. (Follin, R. Volkmann.) This measure is applicable only to the limbs; everywhere else, simple extirpation is an unsatisfactory operation. (Follin, Jamain and Terrier.) Croft¹ amputated the leg of a patient affected with an encephaloid cancer of the lower extremity of the tibia. Ten months afterwards there was recurrence at the lower end of the femur, the surgeon practised disarticulation at the hip-joint, and the patient again recovered from this operation. Unfortunately we do not know what became of him afterwards.² In all cases of carcinoma occupying the bones of the limbs, amputation is inevitable; and amputation at the nearest joint should be practised whenever it is possible.

¹ Lancet, Aug. 24, 1872.

² Dict. Encycl.





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